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THE WIRE ROPE STREET RAILWAYS OF SAN FRANCISCO, CALIFORNIA.

By A. S. HALLIDIE.

This system of street railroad, the invention of Mr. A. S. Hallidie, was put in use by the Clay Street Hill Railroad Company, in the City of San Francisco, California, August, 1870, since which time it has been constantly running, and has been found to answer all requirements, and to exceed the expectation of engineers and others who had examined the plans of the inventor; and has been adopted by other companies in San Francisco.

It is adapted to all kinds of metropolitan railroading, where the surface of the streets has to be kept free from obstructions, where locomotive steam engines are not permitted, or where the streets are so steep as to make the use of horses difficult or impossible.

The system consists of an endless wire rope placed in a tube below the surface of the ground, between the tracks of a railroad, and kept in position by means of sheaves, upon and beneath which the rope is kept in motion by a stationary engine, the power being transmitted from the motor to the rope by means of grip or other suitable pulleys, and from the rope to the cars on the street by means of a gripping attachment fixed to the car by a steel bar, and which passes through a narrow slot in the upper side of the tube.

It presents no impediment to ordinary travel. The rope is grasped and released at pleasure by a peculiar gripping device attached to the passenger car, and controlled by a man in charge. The car is more smoothly started than by horses, and instantly stopped on any part of the road; its mechanical construction is simple and easily controlled, and on the streets it does not frighten horses or endanger lives.

A description of this system, as in use by the Clay Street

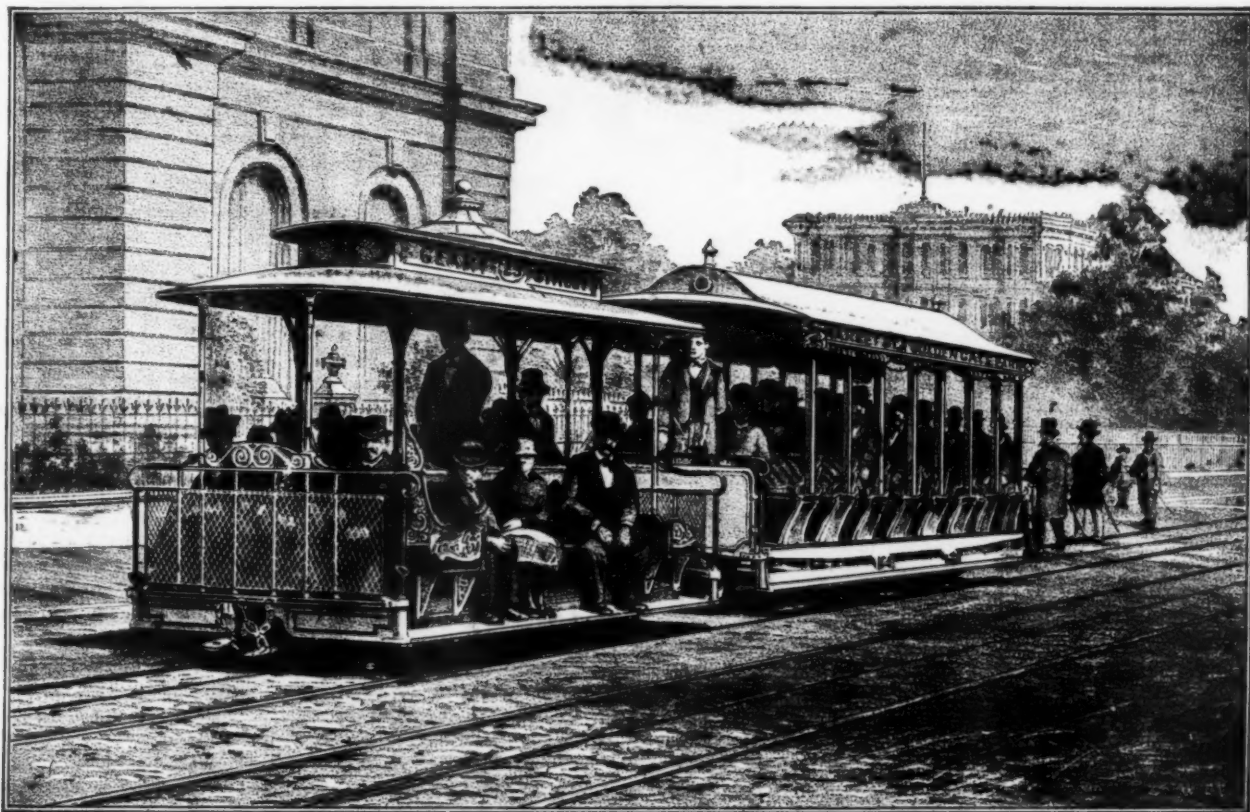
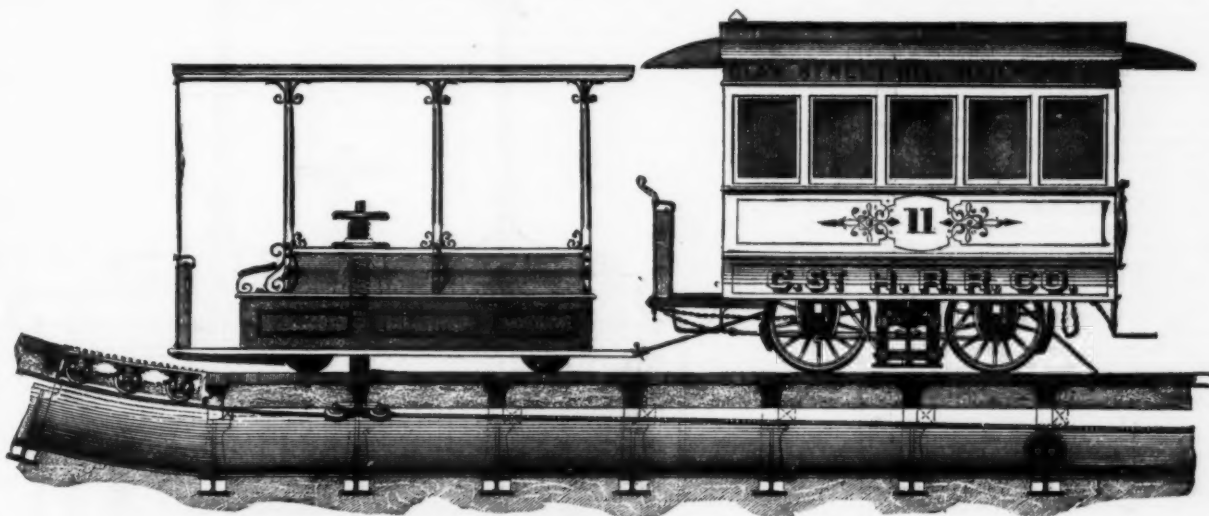
Hill R. R. Co., of San Francisco, will best explain the *modus operandi*:

Clay street is a central street in the City of San Francisco, and for a number of blocks near the lower terminus of the road is very densely populated: the street is only 40 feet wide from house to house, and between the sidewalks is occupied by two lines of gas pipe, one line of water pipe, a street sewer, and at the cross streets by water cisterns.

The lower terminus of the road is at the intersection of Kearny and Clay streets. The summit of the hill is 307 feet above Kearny street. The incline on Clay street has a double track, and is 5,197 feet long; the rope runs into the engine house at Leavenworth street. The ascending grades are as follows (see profile of street grades, Fig. 7): From Kearny to Dupont, 45 feet; from Dupont to Stockton, 45 feet; from Stockton to Powell, 63 feet; from Powell to Mason, 42 feet; from Mason to Taylor, 48 feet; from Taylor to

PASSENGER CAR AND DUMMY,

WITH GRIPPING ATTACHMENT, WIRE ROPE AND SIDE SECTION OF TUBE



CLAY STREET WIRE ROPE RAIL ROAD.

MUCH OF THE TRACK OF THIS COMPANY WAS FORMERLY AND IS NOW USED BY THE HORSE CARS OF OTHER COMPANIES.

THE CABLE STREET RAILWAYS OF SAN FRANCISCO.

Jones, 67 feet. Then the grade descends, as follows: Jones to Leavenworth, 15 feet; Leavenworth to Hyde, 50 feet; Hyde to Larkin, 50 feet; Larkin to Polk, 45 feet; and then an ascent of 15 feet from Polk street to Van Ness avenue. The distance between each street is 419½ feet. Clay street runs at right angles to the above streets, which have widths varying from 45 feet to 68 feet 9 inches. All the street crossings are level. The steepest grade is 1 in 6½.

The general arrangement of the system in use by the Clay Street Hill Railroad is as follows:

An endless steel wire rope, three inches in circumference, 11,000 feet long, is stretched the whole distance, lying in iron tubes, supported every 39 feet on 11-inch sheaves. This rope is supported at every change of angle at the lower crossings on sheaves four feet in diameter, passing around a horizontal sheave eight feet in diameter at the lower end of the line, and at the engine house around two angle sheaves, each eight feet in diameter, which lead the rope on the grip pulleys, also eight feet in diameter, which are driven by one 14 x 28 engine. The steam is furnished by one boiler 16 feet x 54 inches, using 3,700 pounds of coal per day. They have also duplicate engine and boiler, which are held in reserve.

The patent grip pulleys, being furnished at their circumference with jaws that grip and release the rope automatically by the pressure of the rope in the jaws, prevents the rope from slipping; and being set in motion by the engine actuates the endless rope, while traveling up one tube and down the other.

In addition to the sheaves that support the rope in the tubes, at the upper side of each crossing, where the incline makes an angle upward, there are sheaves in the tubes that keep the rope down and from striking the upper part of the tube.

It will be understood that there is an opening in the upper side of the tube. This opening runs the entire length of each tube, forming a long slot seven-eighths of an inch wide. This slot is not immediately over the center of the tube, but on one side, to keep sand and dirt from falling on the rope, to clear the upper sheaves, and enable the foot of the gripping attachment to pass by and under the upper sheaves, and over the lower sheaves in the tube.

The connection between the cars on the street and the traveling rope is made by means of this gripping attachment, which is hereinafter described. The cars are made to seat 14 passengers, and the dummy 16, but not seldom as many as 44 have ridden in the car, and 26 on the dummy—70 in all; and the roads with broad gauge, larger cars, and more even grades have, in one load on car and dummy, carried as many as one hundred and sixty passengers. It is true, they were crowded, but this is always the case on holidays. The traction car, or "dummy," with the gripping attachment, is attached to the passenger car firmly, so that there can be no danger of accident. The passenger car is amply provided with brakes. In addition to the usual car brake, there is another attachment operated in the same manner as ordinary brakes, which forces a broad band of wood down on each track immediately under the car. This arrangement is shown in our first engraving. Strong iron drags are provided, so that if an accident should occur in going up the hill, they will immediately catch in the street, and prevent the car from going backward. When it is necessary to back down hill, these drags are raised up out of the way by the conductor.

The "dummy" is also provided with powerful brakes. The "dummy" and car are connected with a suitable coupling, so that the weight of the car going down comes on the rope and is utilized to draw up the other cars on the other track. The brakes are not usually employed when coming down, except when it is necessary to stop, as the car runs down with the same speed as the rope, as long as the gripping attachment is in connection with the rope.

By referring to the engravings, the system will be more clearly understood. The first engraving is a side view of road and car and dummy; the tube is in longitudinal section and shows the arrangement of the rope; the upper pulleys for keeping the rope down where the grade changes upward, and the lower or supporting pulley, also the gripping device attached to the dummy and to the rope.

The next is an engraving entitled, "Section through Dummy and Road-bed," showing the tube, supporting pulley, rope, and gripping device, and the general mode of construction of the same.

Then we have an isometrical view of the road-bed—a portion of the tube being removed to show the gripping device attached to the rope; the lower end of the shank is only shown being broken off in the drawing, being sufficient for the purpose; the construction of the tube and the tube frames is clearly shown, and the appearance of the rails and slot and surface of the street when paved.

Figures 4 and 5 show the patent gripping attachment in two different positions. A vertical slide works in a standard, and is moved up and down by a screw and hand-wheel. This screw is shown on the cut of dummy and road-bed. The small upper screw going down through the large screw, operates it. At the lower end of this slide is a wedge-shaped block. The wedge actuates two jaws, horizontally, which open and close according to the direction in which the slide is moved, closing when the slide is moved upward. These jaws have pieces of soft cast iron placed in them, which are easily removed when worn out. These pieces of iron are of proper shape and size inside to grip the rope when they are closed over it.

On both sides of these jaws, and attached to them, are two small sheaves. These sheaves are held by means of rubber cushions, sufficiently in advance of the jaws to keep the rope off from the jaws, and at the same time to lead the rope fairly between them, allowing it to travel freely between the jaws, when they are separated, without touching them. When it is required to grip the rope, this slide is drawn up by means of the small screw before described, and the wedge at the lower end closes the jaws over the rope, at the same time forcing back the small guide sheaves on to the rubber springs. The standard containing the slide, etc., is inclosed and retained in an iron bracket, shown on the dummy, Fig. 2, and raised and lowered bodily through an opening in the tube from above the surface of the street to the rope in the tube by means of a screw and nut with hand-wheel attached. The iron bracket is secured to a skeleton or traction car called a dummy, as shown in first engraving. The dummy is coupled to the passenger cars, at the bottom of the incline, and uncoupled at the top, and vice versa; horses can then be coupled to the car if desired. As before stated, the rope is constantly in motion, running between sheaves placed in the tube. The slot of the tube is on one side of a vertical line drawn through the center of the tube; and referring to Figs. 4 and 6, it will be seen that the foot of the gripping attachment projects on one side, giving it an

L shape, enabling the jaws to pass under and over the rope sheaves in the tube. In order to stop the car, the jaws of the gripping attachment are opened slightly; when they release the rope, the guide sheaves take it, and the car stops.

The shank of the standard containing the slide, which works in the slot of the tube, is one-half of an inch thick and 5½ inches wide, there being one-eighth play on each side; all the essential parts of the gripping attachment are made of steel.

The rope runs 17½ hours per day, at a speed of 6 miles per hour. The cars start every five minutes, except in the afternoon, when they start every three minutes.

The road has a gauge of 3 feet 6 inches. An ordinary 30 pound steel T rail is used on Clay street, which is set flush with the street and presents a neat, smooth appearance. The stretching arrangement at the lower end has a counter-balance of 3,300 pounds weight on a double purchase, which keeps a constant strain on the rope under all circumstances.

This machinery is so arranged that the wire rope passes for some distance in open view of the engineer, so that it can readily be examined at any minute.

The hill is the best portion of the city for residences, and the road brings within five minutes of the business portion of the city a large amount of property that was comparatively worthless on account of the difficulty of access, but is now much sought after, having trebled in value since the road was completed.

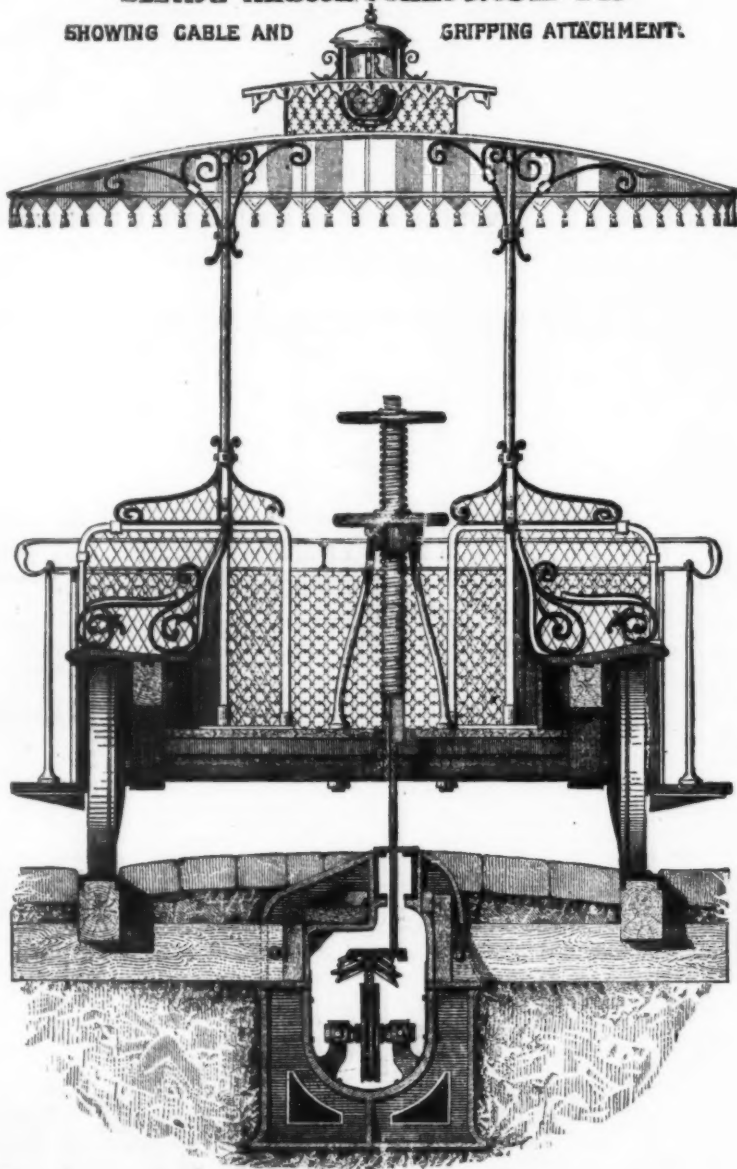
work, and will be two miles long when completed. It ascends a hill 246 feet above its initial point. The estimated cost of constructing this road, which is five foot gauge, double track, runs over high hills and much of it through hard rock, is two hundred and ten thousand dollars. This includes lot, engine house, all the machinery, road bed, cars, and full equipment throughout. Of course, in other cities where material and labor are cheaper and ground more favorable the cost would be much less. (See profile of street grades.)

Although this system was first adopted on roads where the grades are too steep for horses to work to advantage, the economy of its working has so demonstrated itself that all the level roads in San Francisco have obtained amended charters giving them the privilege of turning their horse roads into rope roads. The wear and tear on the streets, as well as the accumulation of filth due to horses, are entirely avoided. Humanity is not shocked by the overloading of street cars or the overworking of horses.

In cities where the severity of winter closes traffic for days at a time, this system can keep its own tracks clean by a cheap system of warming in the tube, and by the great traction power of the rope on snow plows and scrapers—a power which it is impossible for horses to produce struggling through the frozen and snow covered tracks.

The saving effected by the employment of this system is from thirty to fifty per cent. on that of horse roads, while its capacity for traffic is almost unlimited. The speed at

SECTION THROUGH DUMMY & ROAD BED
SHOWING CABLE AND GRIPPING ATTACHMENT.



THE CABLE STREET RAILWAYS OF SAN FRANCISCO.

After the Clay Street Hill Railroad had been running three years and a half, and the economy and practicability of the system was thoroughly tested, the Sutter Street Railroad Company, whose lines had for many years been unprofitably worked by horses, changed their system from a horse road to the wire cable system; and by the end of the year 1879 had reconstructed nearly their entire road on this system. This company has now 14,000 feet (over 3 miles) of double track operated on this system. The gauge of the road is 5 feet, and its greatest elevation is 167 feet above its initial point. (See profile of street grades.)

The California Street Railroad commenced running April, 1878. Its length is 12,000 feet, and it passes in that distance over two elevations, the heights being 265 feet and 235 feet above base respectively, the valley between being 125 feet above base. The gauge is 3½ feet, same as the Clay Street. (See profile of street grades.)

The Geary Street Railroad runs over a comparatively level street and through the most central and populous streets of the city. It was completed and commenced running March, 1880. (See profile.)

All these roads are working successfully, and carry in the aggregate about 35,000 passengers daily, at a uniform fare of five cents.

Several other roads are projected on this system, among which the Presidio Railroad Company has commenced

which the cars travel is from six to eight miles per hour. The Traction Railway Company of San Francisco have the control of this system of street railroading.

RECENT PROGRESS IN THE MANUFACTURE AND APPLICATIONS OF STEEL.*

By PROF. A. K. HUNTINGTON, King's College, London.

At first sight, the title which I have given the paper I am about to bring before you this evening, might lead some to suppose that it was intended to deal with very recent events, such as might have occurred within the last few months, or say a year. Such anticipations would be fully justified were I to address you on recent progress in the applications of electricity, for this offspring of intellects of our own era makes marvelous progress from day to day, until one feels tempted to concede to it a position in the universe similar to that occupied in the human body by nerve force. In fact, the want of continuity between our nerve system and what we may call that of the world is fast becoming less and less. We can already flash our ideas and our voices to the farthest parts of the earth, and the reproduction of the images of material objects by similar means seems to be in a fair way of accomplishment. But the subject of our attention to-night

* A lecture recently delivered before the Society of Arts, London.

FIG. 6
CROSS SECTION OF TUBE, PULLEYS, ETC.,
OF
CLAY ST. HILL R. R.

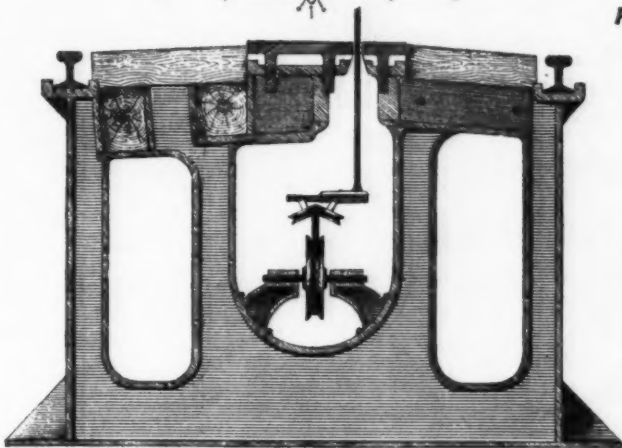
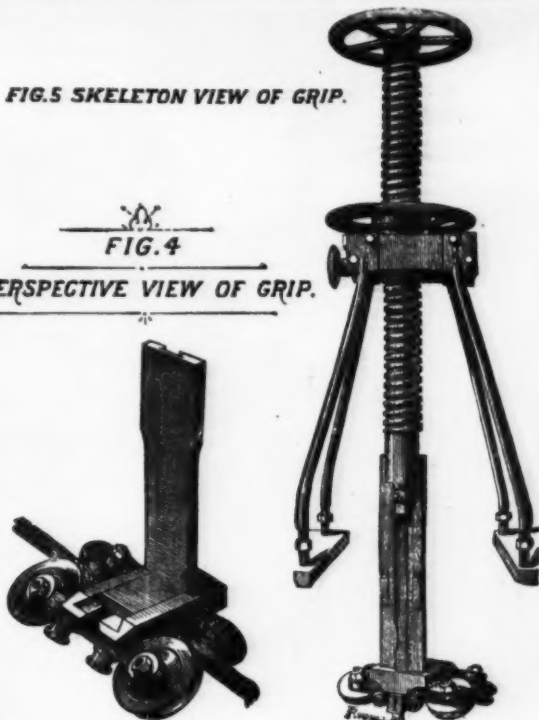


FIG. 5 SKELETON VIEW OF GRIP.

FIG. 4
PERSPECTIVE VIEW OF GRIP.



had its commencement in times so remote as to be far beyond the reach of human record, and its rate of progress may be measured by that of the world itself in the arts and sciences.

Improvements in the arts and sciences have gradually modified the methods of producing iron and steel; and, in their turn, the arts and sciences have felt the reaction; for all improvements in the manufacture of iron and steel have been not so much in the production of a better quality of article, but in the cheapening of production, by the application of the principles indicated by the progress of science, and by the use of superior machinery. The direct result of this cheapening has been to extend the applications of the products in the arts. To appreciate this, let us glance back, and see by what means steel was produced up to the year 1855, and what were its applications, and then trace out the causes of the changes which have since taken place in these respects.

The discovery of steel appears to have naturally followed that of the means of reducing iron from its ore. In all primitive methods of iron smelting, steel, in more or less quantity, is inevitably produced. Such methods have been carried on in India and Africa from time immemorial to the present day. A similar furnace has, for several centuries, been employed in Catalonia, in Spain. The comparative cheapness of iron manufactured in other countries by improved methods, is, however, rapidly causing this furnace to pass out of use.

I propose now briefly to describe to you the process in the Catalan furnace, as it is called, in the form into which it has developed in Spain and the South of France, in order that we may clearly understand the essential differences between iron and steel, both as regards their composition and properties, and also the conditions requisite in the production of each.

MODE OF CONDUCTING THE PROCESS.

The ore is crushed by the hammer, and divided by sifting into lumps ("mine") and very coarse powder ("greillade"). The furnace being still red-hot from the last operation, it is filled with charcoal nearly to the tuyere; the hearth is then divided at a point about two thirds distance from the tuyere into two parts by a broad shovel; on the blast side a further

quantity of charcoal is added, while that on the other side having been rammed down firm, ore is added, so as to fill that part of the furnace; on this is placed moistened charcoal dust, except at the top. A good blast is then turned on, and if the whole is in good order, jets of blue flame at once issue from the uncovered portion of the ore. After a few minutes the pressure of the blast is lowered to 15 in. of mercury. At intervals during the process—which lasts about six hours—the blast is gradually raised until it reaches about 3 in., the maximum usually employed.

During the whole of the process, at short intervals, "greillade" and charcoal are added, and well moistened with water, to prevent too rapid combustion. After about two hours from the commencement, the wall of "mine," i. e., ore in lumps, is pushed well forward under the tuyere, and more "mine" is thrown into the space thus made; this part of the process is also subsequently repeated at intervals, until sufficient has been added to form a lump of iron or mass of the required size. From time to time slag is removed by opening the tap-hole. At the completion of the process, a mass of metal is obtained weighing about 3 cwt., which invariably consists partly of soft iron, and partly of steely iron and steel.

REACTIONS IN THE FURNACE.

We have seen that in the one part of the furnace only charcoal and "greillade" are introduced, and in the other only lumps of ore. That the ore should be in lumps at that part is a very important point, for in this way the hot reducing gas, carbonic oxide (CO), generated by the action of the blast on the charcoal, is able to pass freely through the mass of the ore, the effect of which is that the water of hydration and the moisture are first driven out by the heat, and then the ore having become easily permeable, the carbonic oxide reduces it to metallic iron, thus, $\text{Fe}_2\text{O}_3 + 3\text{CO} = 2\text{Fe} + 3\text{CO}_2$. There are, however, several stages in this reduction, magnetic oxide being first formed, thus, $3\text{Fe}_2\text{O}_3 + \text{CO} = 2\text{Fe}_3\text{O}_4 + \text{CO}_2$; and protoxide is next formed before metallic iron is obtained, thus, $2\text{Fe}_3\text{O}_4 + 2\text{CO} = 6\text{FeO} + 2\text{CO}_2$, and $6\text{FeO} + 6\text{CO} = 3\text{Fe}_2 + 6\text{CO}_2$. At the same time that these reactions are going on, the ore has become impregnated with carbon, derived from the decomposition of the gases with which it

is charged. That this would be the case, the experiments of Mr. Lowthian Bell and others can leave no manner of doubt.

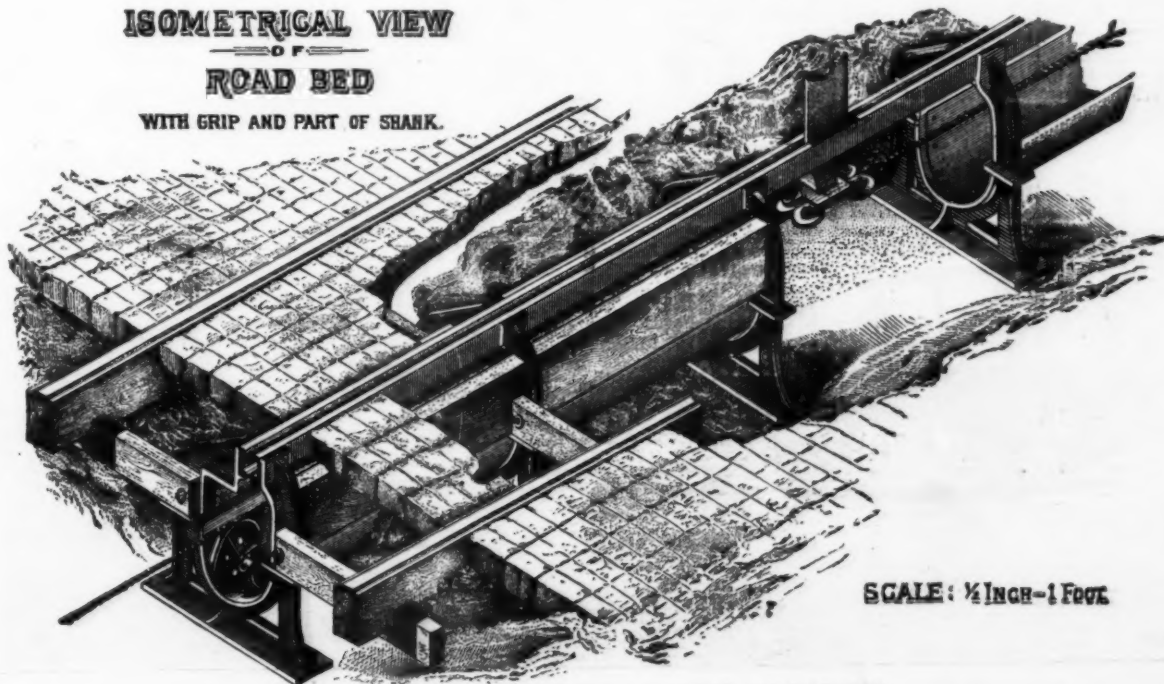
On the tuyere side, where are placed the charcoal and "greillade," the latter, as the charcoal is burnt away, descends rapidly, and, to a considerable extent, doubtless, escapes reduction, for the arrangement of the blast is such that most of the reducing gas is projected on to the lumps of ore, and does not pass up through that portion of the furnace occupied by the charcoal and "greillade," which, besides, are constantly damped. This "greillade" is much richer in silica than the larger pieces, from which it results that the quantity of slag will vary with the "greillade" added. It is always very rich in oxide of iron.

Now, what happens in this process appears to be this: carburized iron is produced by the gradual reduction and fusion of the lumps of ore, and this, coming in contact at the bottom of the furnace with slag, very rich in oxide of iron, the carbon of the one combines with the oxygen of the other, and the result is that iron containing more or less carbon is produced, according as much or little oxide was present.

The obvious conclusion would be, that the less there was of "greillade" present the more steely would be the iron; in practice this is found to be the case. This circumstance would naturally suggest the total suppression of the "greillade," when it was desired to produce steel. This would, however, be impracticable, for it is necessary that some of the oxide of iron should remain unreduced in order to flux off the silica, which occurs in considerable quantity in the ore. In the blast furnace, this difficulty is got over by employing lime; but lime at the temperature of the Catalan furnace would not produce a sufficiently liquid slag.

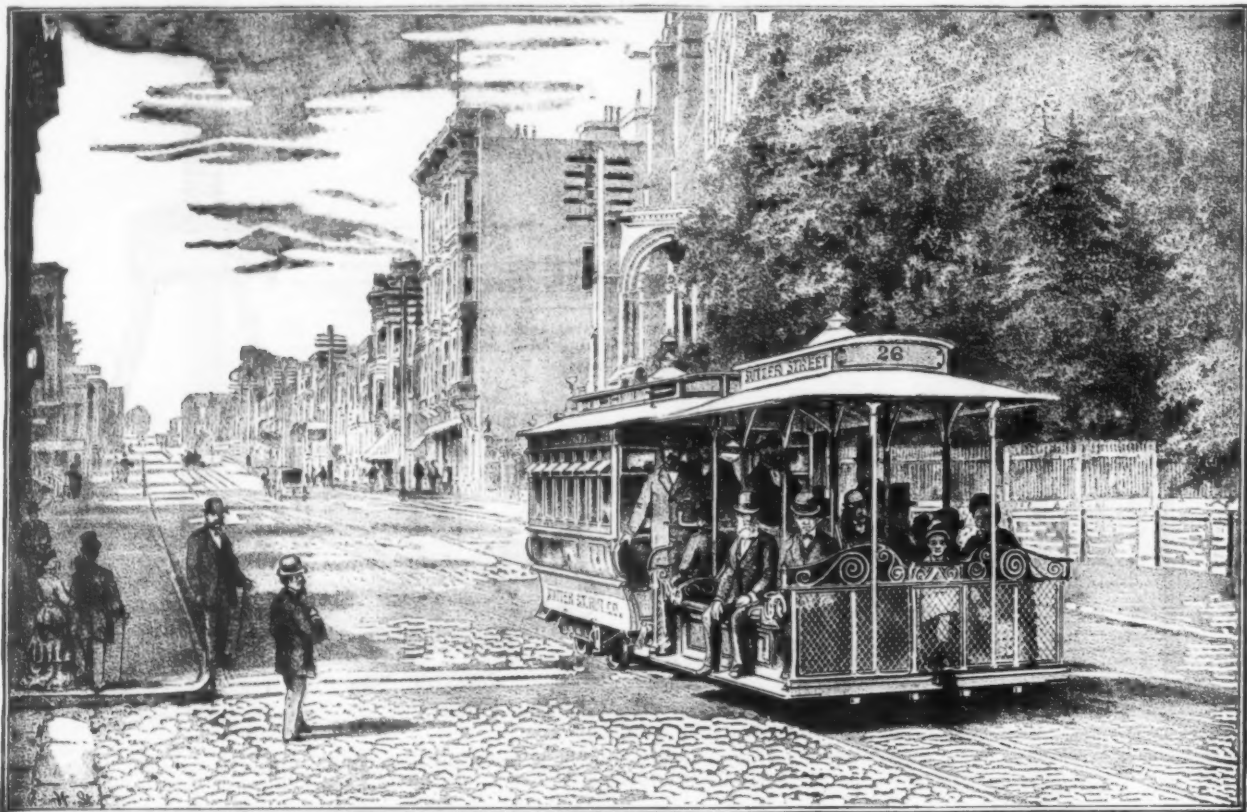
All that can be done, then, is to employ every available means to prevent decarburization. Accordingly we find that when steel is required, in addition to using less "greillade," the slag is tapped out more frequently, so that the lump of iron, as it forms, may remain as little time as possible in contact with it. The bank of ore is exposed for a longer time to the reducing and carburizing gases, and is pushed more gently toward the tuyere, so as not to become decarburized by the air which has not had time to

ISOMETRICAL VIEW
OF
ROAD BED
WITH GRIP AND PART OF SHANK.



SCALE: 1/2 INCH = 1 FOOT

THE CABLE STREET RAILWAYS OF SAN FRANCISCO.



SUTTER STREET WIRE ROPE RAIL ROAD.

THIS FORMERLY A HORSE ROAD, WAS CHANGED TO A WIRE ROPE ROAD.

combine with the carbon of the charcoal. Lastly, manganese should be present. It is found that the presence of manganese has a very important influence, which is probably due to its power to replace iron in the slag. A slag containing manganese is more liquid than if it contained iron alone, and, according to François, has not the same tendency to cause decarburization at the temperature of this process.

In order, then, that steel may be produced by this process, every precaution is taken to cause as much carburization as possible; the unavoidable presence of oxide of iron in the slag and the low temperature effectually preventing the formation of cast iron; the former, indeed, making it very difficult, as we have seen, to obtain steel.

It might be said, Why not increase the temperature, so as to obtain a liquid slag without using oxide of iron? If the temperature were increased, cast iron, instead of steel, would be produced; in fact, that is exactly how cast iron first came to be obtained in blast furnaces.

I have gone rather fully into this process, because the principle of it is not always well understood. Rightly looked at, it explains how steel was first obtained, and what the essential conditions are in the production of steel. When, owing to the increased size of blast furnaces, and the consequent increase in temperature, cast iron became the only product, it naturally followed that this substance

should be treated with a view to the production of steel. This was first effected in the fining hearth, and formed an important industry in Styria, Carinthia, the Tyrol, and other places, in some of which it is still carried on.

The operation was conducted in a finery, similar in construction to those employed in the production of iron—in fact, iron and steel are often produced alternately in the same finery. This furnace, in its simplest form, consists essentially of a shallow quadrangular hearth, formed of cast-iron plates. In one side is a tuyere, inclined at an angle of 10° to 15° . The bottom is kept covered with a layer of charcoal.

In the Siegen district, a piece of pig iron, weighing 50 lb. to 60 lb., is placed on the hearth, having been previously heated; the hearth is then three-parts filled with burning charcoal; on it is placed a portion of the cake produced in the last operation, and which has been kept hot in burning charcoal, at the back of the furnace. The remainder of the hearth is then filled up with charcoal. The other six or seven pieces into which the last cake was divided are placed on the top. In this process the production of steel, and the reheating of that obtained in the last operation preparatory to working it under the hammer, are conducted together. The blast is turned on. The piece of pig iron forms into a pasty mass; cinder, rich in oxide of iron, produced during

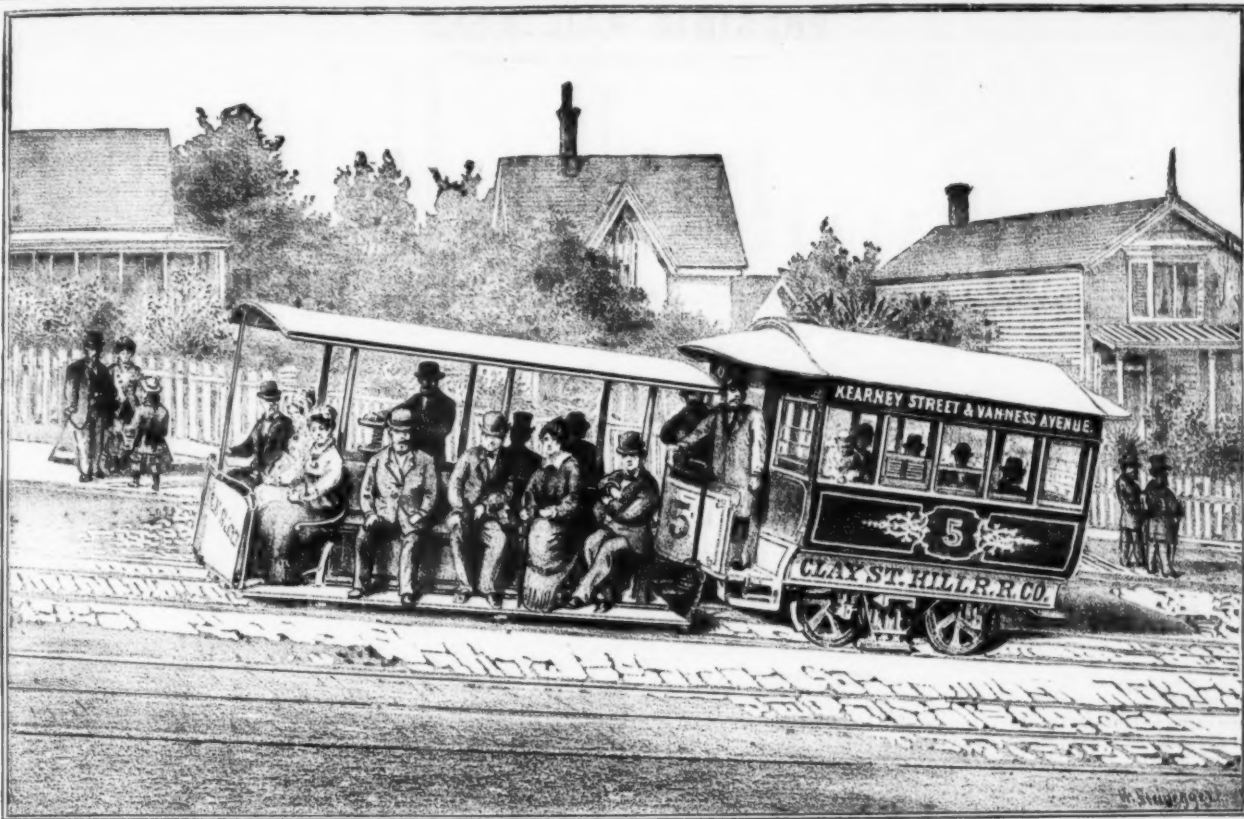
the latter part of the preceding operation, is then thrown in; a second piece of pig-iron, weighing about 100 lb., is added, and, afterwards, four or five pieces of spiegeleisen, weighing each about 100 lb., are successively added. (Spiegeleisen is cast iron containing manganese, in this case about 4 per cent.) If the metal is found to be too much decarburized, more spiegel is added. The cinder is usually allowed to rise 2 inches or 3 inches above the cake of metal, any excess being tapped off. There are several modifications of this process, but I have said enough to make the principle clear. In this process, as in the Catalan, it is impossible to obtain a homogeneous product. The principle in both is essentially the same, viz., decarburization by oxide of iron. In the finery process, in addition to the oxide added in the form of cinder and scale produced during the working of the metal under the hammer, some results from the reheating, which we have seen is carried on at the same time. In this process manganese also plays an important part, and we shall see that in every process for the production of steel, manganese is used with great advantage.

With one notable exception—the cementation process—the early methods for the production of steel were simply modifications of the methods for producing malleable iron. Accordingly, we find that the introduction of the puddling process, by which malleable iron is produced in a reverber-



CALIFORNIA STREET WIRE ROPE RAIL ROAD.

AT A POINT 225 FT ABOVE THE BAY, HAVING ATTAINED AN ELEVATION OF 420 FT IN A DISTANCE OF 1375 FEET.



CLAY STREET HILL WIRE ROPE RAIL ROAD.

ASCENDING AN ENCLINE OF ONE FOOT IN SIX. — THE FIRST CABLE ROAD CONSTRUCTED.

tory furnace, was soon followed by a similar process for the manufacture of steel.

The essential difference between the finery and the puddling process consists in the use of a reverberatory furnace, the manipulation of the metal and the regulation of the temperature being thereby greatly facilitated. The decarburization is effected by the addition of oxide of iron produced during rolling, and partially by the air which enters the furnace as the metal melts slowly down; manganese is added during the process.

It is important that the temperature should be kept low. It is difficult to weld this steel perfectly; this is probably due to the temperature at which the steel has to be worked being too low to make the cinder sufficiently liquid to enable it to be squeezed out under the hammer to the same extent that it is in the case of malleable iron. This difficulty has, however, been got over by completely fusing the steel before working it, so as to enable the slag to completely separate. In this form metal manufactured by this process has been largely used by Krupp. This defect is common to all steel which has been produced without fusion.

The same principle as that which regulates the production of steel by the foregoing methods is taken advantage of in the Uchatius process, which was patented in 1855.

Pig iron is first granulated by running it while molten into cold water. The granulated metal is then mixed with about 20 per cent. of roasted spathic ore, crushed fine; the mixture, to which a little flux has been added if necessary, is then fused in clay crucibles. If very soft steel is required, some wrought-iron scrap is added.

Lastly, in this category we have a process which consists in heating cast iron, but not so as to soften it, in oxide of iron, in the form of ore or iron scale. In this way partial,

or even total, decarburization of the metal can be produced at will.

So far we have seen, then, that the difference between iron and steel is merely one of degree depending on the amount of carburization. The methods we have considered, in fact, are only modifications of those practiced for the production of malleable iron.

We will now pass to the brief consideration of the different methods of procedure for the production of steel, which, however, I think I shall be able to show, naturally resulted from the observation of phenomena occurring in the first process we have had under consideration.

These processes have for their object to impart a certain amount of carbon to malleable iron. The Hindoos have practiced one of them from time immemorial. They place in unbaked clay crucibles, of the capacity of a pint, a piece of malleable iron and some chopped wood and a few leaves of certain plants; the top of the crucible is then closed with clay and the whole well dried near a fire. A number of these crucibles are then strongly heated for about four hours in a cavity in the ground, by means of charcoal and a blast of air forced in by bellows. There is some reason to believe that an excess of carbon, over that required to produce the hardest steel, has to be added, in order to fuse the metal at the temperature which can be commanded in these furnaces. Before being drawn out into bars, the cakes of metal obtained in this way are exposed in a charcoal fire during several hours to a temperature a little below their melting point, the blast of air playing upon them during the time. The object of this is, doubtless, to remove the excess of carbon.

In 1800 a patent was taken out by David Mushet, for a process in every respect analogous to that just referred to.

He appears, however, to have applied it to the manufacture of a metal low in carbon, and therefore intermediate between iron and steel, partaking in a certain degree of the properties of both, corresponding, in fact, to what we have referred to as steely iron. Since this metal must have been in a state of fusion, Mushet must have brought to bear upon it a very high temperature. The manufacture was conducted in crucibles.

In another method referred to by Biringuccio, in 1540, steel is produced by keeping malleable iron in molten cast iron until it became pasty, and on examination was found to possess the properties of steel. In connection with the theory of steel manufacture this process is of great interest. It shows that iron in a strongly-heated condition is capable of absorbing carbon by direct contact, unless we suppose that the carburization is effected by dissolved gases, which is possible, for Graham and others have proved that iron can occlude gases even when it is in a solid state.

If we admit that the mutual affinity of carbon and iron is such as to cause them to unite at the temperature of molten cast iron, it is then not difficult to conceive how the whole mass becomes carburized without the intervention of occluded gas. In asking you to concede that the surface of the iron enters into combination with the carbon in this way, I am strictly within fact, as shown by the Hindoo and Mushet processes. A marked case of this kind occurs when sulphur and silver or copper are brought together at the ordinary temperature, combination taking place.

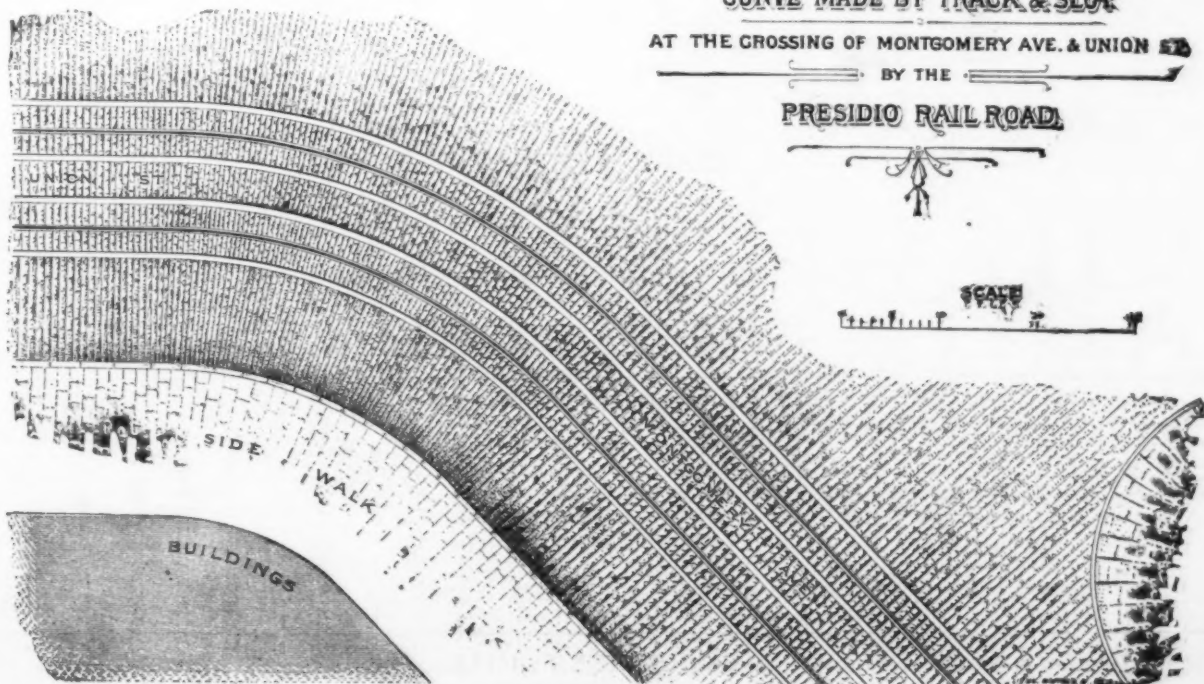
The particles of iron at the surface having taken up carbon, their affinity would be satisfied, but the affinity of the atoms contiguous and beneath would at once come into play, and would only be satisfied by an equal division of the carbon between themselves and those on the surface.

CURVE MADE BY TRACK & SLOT

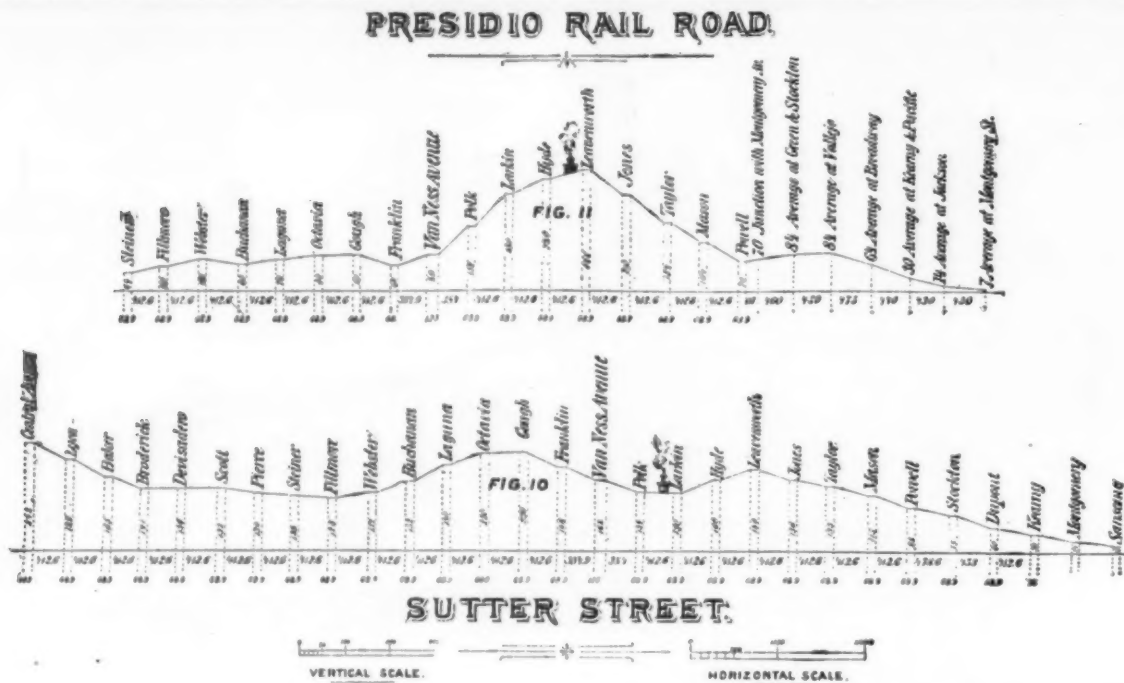
AT THE CROSSING OF MONTGOMERY AVE. & UNION ST.

BY THE

PRESIDIO RAIL ROAD



THE CABLE STREET RAILWAYS OF SAN FRANCISCO.



Imagine a man carrying four cannon balls, his strength just sufficing for the task; he encounters an enemy equally strong, but who is unencumbered, and, therefore, in the possession of his whole strength.

For the sake of simplicity, we will call the man carrying the cannon balls, A, and the other, B. B first applies his whole strength to wrest one ball from A, and succeeds, for the chances are 4 to 1 in his favor, A holding the ball only with a fourth part of his strength, whereas B applies the whole of his. B then tries to obtain another ball from A, and again succeeds, for the force he applies in relation to the resistance offered by A is as 3 to 3. A and B are now on an equal footing; each is capable of taking up two more cannon balls, should the opportunity present itself.

Now, let the cannon balls be represented by the carbon atoms, and A and B by the surface and the inner contiguous particles of iron, then the bath of molten cast iron will form a reservoir from which A can recharge itself. In the mean time other particles, C, will have deprived B of part of its carbon, just as B did A, and B will, therefore, be again in a position to obtain carbon from A.

The same reasoning would apply to each successive layer of metal throughout the mass, that on the surface taking up carbon continuously from the bath of molten metal, until, if the process were continued long enough, the malleable iron would become converted into cast iron of the same composition as that in the bath, into which finally it would dissolve.

We now come to what is called the cementation process. It is not known when this process was first used. It was well described by Reaumur in 1723. In this method bars of iron are kept at a glowing red heat, surrounded with charcoal in boxes, into which the air is prevented from entering. The operation lasts from seven to ten days, according to the quality of steel required. These bars are never uniformly carburized, and, besides, they contain cinder, as the metal has never been fused. The process had been a long time in use, however, before it occurred to any one to fuse the steel and make it homogeneous. This was done by Huntsman, about 1760. It was the first time that steel had ever been

intentionally obtained in a molten state, unless we except the Hindoo process, but the fused product in that case was probably too highly carburized to constitute steel. I have already premised that the addition of carbon to malleable iron, in order to produce steel, resulted from the observation of what took place in the processes first described. It was, in fact, a matter of common observation that iron, no matter whether solid or molten, kept in contact with carbon, became more or less steely. What more natural than to endeavor to produce steel directly in this way?

By all the processes we have so far reviewed, good steel could be produced, but only in small quantity and at great expense. The applications of steel were, in consequence, very limited; in fact, practically, its use was confined to implements with a cutting edge.

In 1845, Heath patented a process which, had it been successful, would have given him the power of producing steel in quantity. He proposed to melt scrap iron in a bath of molten pig iron in a reverberatory furnace heated by jets of gas. There were two conditions wanting in this method which caused it to be a failure, viz., a sufficiently high temperature and the power to easily regulate the character of the gases employed. Nevertheless, in this suggestion is to be found the germ of one of the two most important processes of the present day. By the foregoing remarks I do not intend to imply that the idea of mixing wrought and cast iron together to produce steel was originated by Heath. On the contrary, as we should expect, this idea was a very old one.

In 1723, Reaumur tells us that he succeeded in making good steel in a common forge in this way. As far as I am aware, however, Heath was the first to suggest the use of a reverberatory furnace and gas for the purpose, and that is the important point.

It may here be pointed out that the manufacture of steel by this method does not depend by any means entirely on the adjustment of the relative proportions of wrought iron and pig iron, as appears sometimes to be thought by those not specially acquainted with the process. There is a good deal of oxidation going on during the operation, which

results in the elimination of an equivalent proportion of carbon from the pig iron.

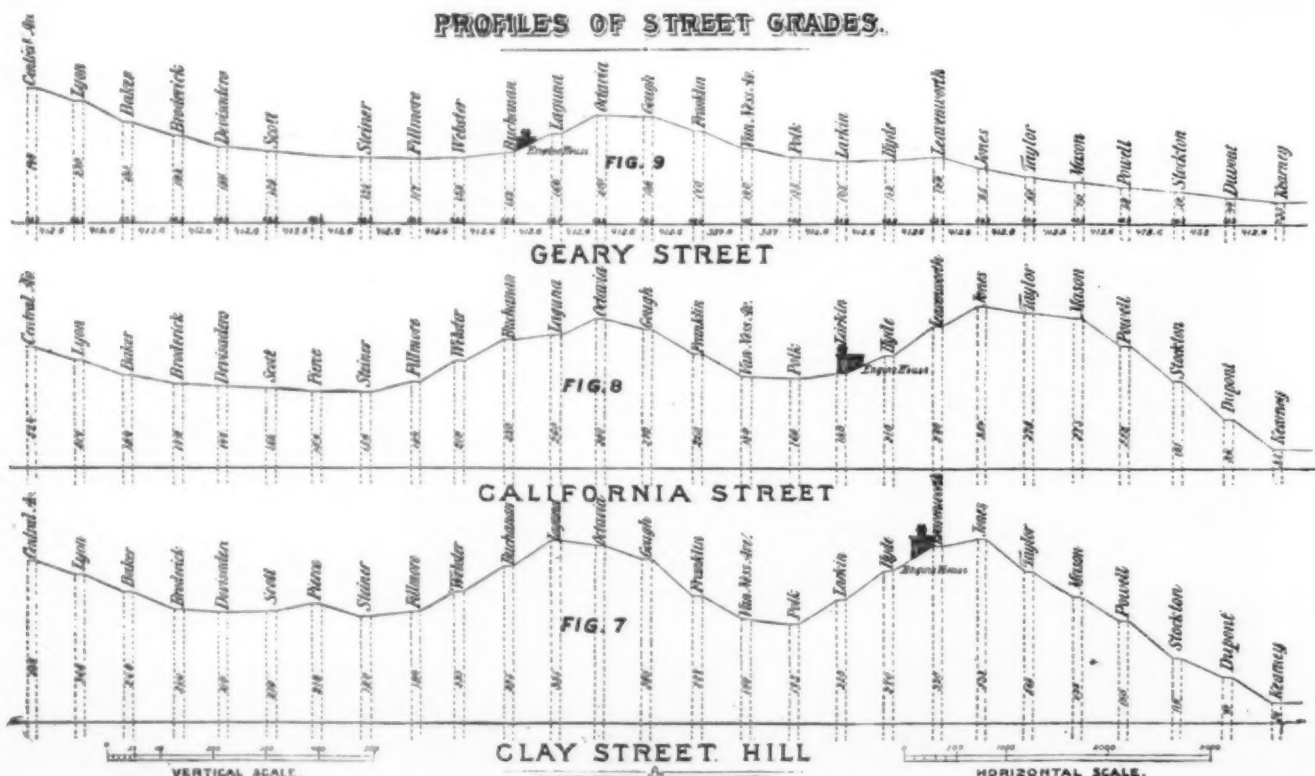
The dominant idea in treating cast iron for steel had always been to refine the metal by the action of atmospheric air, and this was effected by causing a current of air to impinge upon the surface of the metal, by means either of blowing apparatus or the drawing action of a chimney stack. What more natural than that it should occur to some one to refine iron by blowing air into it, instead of merely on to its surface? We find that this idea did actually occur to several persons, widely separated, in the year 1855. It is a noteworthy fact that a very large number of what we call discoveries or inventions are made simultaneously and independently in different parts of the world by people who previously had probably never heard of one another.

It would seem as if the records of observations accumulated in men's minds and in books until they naturally pointed to certain conclusions. The man who follows up these conclusions, and applies them in practice, is not always the one who first perceived them. To carry out what appears to the world at large as new ideas requires great strength of purpose, and such a combination of circumstances as to afford an opportunity.

In this year (1855) a patent was taken out by John Gilbert Martien, for refining iron, by forcing air through it as it flowed from the blast furnace or cupola, along runners, to the puddling furnace.

This conception was a very important one in the sense that, had not others been working in exactly the same direction at the same time, it would probably have assisted in working out the problem involved. The process, as detailed in the patent, was impracticable, and shows internal evidence of not having been worked out on a manufacturing scale.

Just after this patent was taken out, we find George Parry, of the Ebbw Vale Works, making the experiment of forcing air through molten cast iron, on the bed of a reverberatory furnace by means of perforated pipes embedded in the fire-clay bottom. Vigorous action is stated to have taken place, but, unfortunately for the experimenters, the metal, through an accident, escaped from the furnace, and the further trial



THE CABLE STREET RAILWAYS OF SAN FRANCISCO.

of the process was discouraged by the managing director. There can be no manner of doubt that, had this experiment been continued, very important results would have ensued.

As the Ebbw Vale Company had bought Martien's patent rights, it would appear that their experiments were really based on his idea. Of this I am not, however, certain, as I am not aware of the date at which they made the purchase.

Two or three months after these experiments, Henry Bessemer took out his now celebrated patent for the production of cast steel, by blowing air through molten cast iron; it should be clearly borne in mind that he had been, for a considerable time, previously engaged in experiments on the subject.

Whether Bessemer originally started with the idea of refining pig ready for puddling, and, in the course of his experiments, made the discovery that, by the action of the oxygen of the air on the carbon of the pig iron, such an enormous heat was produced that the resultant iron was obtained in a molten state—a thing never before accomplished—I do not know. The only alternative is that he arrived at the same conclusion by inductive reasoning, which, all things considered, is very improbable.

Bessemer first carried out his process in crucibles, placed in furnaces and arranged so that the contents could be tapped from the bottom into moulds. Steam or air, either separately or together, and by preference raised to a high temperature, was forced down into the crucible through a pipe. The patent goes on to state that steam cools the metal, but air causes a rapid increase in its temperature, and it passes from a red to an intense white heat.

It was, and still is to a less extent, an infatuation of patentees to employ steam in the place of air. Bessemer soon discovered the essential difference which exists in practice, though not realized by the excited imaginations of the majority of would-be inventors. Bessemer at first used extraneous heat to start the process, if not, indeed, during its progress, which shows that he was not then aware that the heat created by merely blowing in air would be sufficient.

In his next patent, taken out shortly after, however, he dispenses with the furnace round the crucible, and, instead of tapping the crucible from the bottom, he mounted it on trunnions, and by tipping it up by machinery poured the contents from the mouth. This apparatus, devised by Bessemer, is essentially the same as that used at the present day. The way in which he worked out the process in every detail to a grand practical success in such a short space of time, shows him to have been possessed of a mind of great powers of conception. Having the facts before him, he drew the right conclusions from them with unerring judgment, and from one experiment passed to another suggested by it, until with indomitable perseverance he succeeded in bringing about greater progress in the manufacture of steel in a few months than had occurred in centuries before.

It was very soon found that, to produce steel by this process which would work properly, manganese, if not originally present, would have to be added. In the absence of manganese, sulphur and oxygen, in anything more than very minute quantities, make the steel crumble when worked at a red heat; it is said to be "red short." In the case of the oxygen, the manganese combines with it, and passes it into the slag; but with sulphur the reaction is different; its injurious effect is simply counteracted by the manganese; it is not removed from the steel.

At first manganese was only employed in the form of spiegeleisen—a variety of cast iron containing manganese. The use of this substance was first suggested by Robert Mushet. When, however, it was attempted to produce very soft steels, a practical difficulty arose. If sufficient spiegeleisen was added to impart the requisite quantity of manganese, then too much carbon would have been introduced. This ended in attempts being made to produce spiegeleisen richer in manganese. By suitably adjusting the conditions in the blast furnace, this was soon easily accomplished; and instead of spiegeleisen containing less than 10 per cent. manganese, a 20 per cent. spiegeleisen was produced.

At the suggestion of Bessemer, attempts were made to obtain a still richer alloy. This was accomplished by reducing richer ores of manganese with cast iron in crucibles or in a reverberatory furnace. These richer alloys are known by the name of ferro-manganese. They are employed with great advantage when very mild steel is being manufactured.

By adding at the end of the process a known quantity of spiegeleisen or ferro-manganese, containing a known quantity of carbon, steel of any required hardness could be obtained. There was but one important drawback to the Bessemer process, and that was that phosphorus was not in the least degree eliminated by it; consequently, only the best ores could be employed, which considerably increased the cost of production over that which it would otherwise have been. I will refer to that point again presently.

The year which saw the birth of the Bessemer process was doubly remarkable, for it was at that time that the regenerative system of heating was first introduced by Dr. Siemens. Nothing can be simpler than the principle involved in this method, yet it was destined to play a most important part in the progress of the arts. The idea was to store up the heat escaping in the waste gases from furnaces, and to employ it to raise the temperature of the gas and air previous to their combustion in the furnace. This was accomplished by causing the spent gases to pass through two chambers filled with loose brick work. When these chambers have become heated to a high temperature, the waste gases are made to pass through two other similar chambers, and the air and gas necessary for combustion in the furnace are caused to pass through the highly heated regenerators. By causing the ingoing gases to pass alternately, at suitable intervals of time, through each pair of regenerators, a very high and, at the same time, uniform temperature can be obtained in the furnace, without any greater consumption of fuel than in the older methods. The success of this process depended entirely on the fuel being first converted into a combustible gas. This was done in a chamber to which only sufficient air is admitted to convert the carbon into carbonic oxide, which is then conducted by tubes to one of the regenerators to be heated, and thence to the furnace, where, coming in contact with air which has been passed through the other regenerator, it burns, giving out intense heat. It is at once apparent that we have here the very conditions which were wanting to make successful the process patented by Heath in 1845, for not only we have the high temperature which could not then be obtained, but it has become easy to create at will, by regulating the relative proportions of combustible gas and air, either an oxidizing, a reducing, or a neutral flame.

There are two methods now in use for the production of steel in the reverberatory furnace, or open hearth, as it is called. In France, pig iron and scrap steel are fused to-

gether; in England, pig iron is decarburized by means of iron ore, some scrap, however, being generally added for the sake of utilizing it. As in the Bessemer process the necessary amount of carbon is imparted to the metal by means of spiegeleisen or ferro-manganese. This process has been largely employed for the production of ship and boiler plates. It has the great advantage that the metal can be kept fluid on the hearth, and its composition adjusted until it is exactly that required.

In 1876, a patent was taken out by M. Pernot, in which it was proposed to produce steel on an open-hearth furnace with a revolving bed, inclined at an angle of 5° or 6° to the vertical. Pig iron previously heated to redness is placed in the bed of the furnace and covered with scrap steel. The bed gradually melts, and the scrap is alternately exposed to the strong heat of the flame, and then dipped under the molten pig iron. In this way the fusion is very rapid comparatively, the whole mass becoming fluid in about two hours. The process is then completed in the ordinary way. When repairs are necessary, the bed on its carriage is drawn out.

In practice, it is found that these furnaces require very frequent repairing. With the view to make this easier, M. Pernot has arranged a movable roof, which has besides the additional advantage of reducing somewhat the strain on the structure occasioned by such great variations in temperature. M. Pernot informs me that he has just taken out a patent for an arrangement of his furnace by means of which he can employ gas under pressure, and that within the last few months he has obtained by this means results which have never been equaled before. He states that, in a seven-ton furnace, he has obtained five charges in twenty-four hours. This, at any rate, contrasts favorably with the figures given by Hackney, in 1875. He says five charges, of about four and a-half tons each, are got out in each twenty-four hours; the coal used being about eight to eight and a half cwt. per ton of steel. The averages obtained with furnaces of similar design, and working under similar conditions, but with fixed beds, he states to have been just about half, and the coal used per ton of steel to have been eighteen cwt. Mr. Holley, of New York, has recently stated that they are getting with the ordinary Pernot furnace a seventeen-ton charge in six and a half hours, all cold stock, except five tons preheated scrap.

The Steel Company of Scotland tried the Pernot system and abandoned it. They appear to have come to the conclusion that, owing to the great trouble and expense in keeping the furnaces in repair, the system possessed no special advantage over the ordinary Siemens furnace. If I am not mistaken, however, the Steel Company of Scotland were using these furnaces for soft steel for ship plates, whereas, in the instances referred to, rail-steel was being manufactured. This is an important difference, the temperature in the former case requiring to be much higher than in the latter, the carbon being less, and the metal, therefore, more infusible; consequently, the wear and tear and attendant expenses would be proportionately greater. Be that as it may, it is beyond dispute that this system has achieved a considerable measure of success abroad, which will probably increase, as modifications, such as I have referred to, are gradually effected to reduce wear and tear, and facilitate repairs.

We now come to the Ponsard furnace. It aims at combining the advantages of the Bessemer and open-hearth processes. The furnace is so arranged that, by giving it a half revolution on its oblique axis, the tuyeres with which it is supplied may be brought either beneath or above the surface of the bath of metal. By these means the metal can be rapidly decarburized nearly entirely, as in the Bessemer converter, and then, by removing the tuyeres from beneath the metal, the final adjustment of the carbon can be made as in the Siemens process. The only difficulty experienced in working out this idea to a practical success appears to be the rapid destruction of the tuyeres. This obstacle is certainly a very great one, and it may possibly be found insurmountable.

It may here be remarked that some firms in France, and, indeed, in England, too, claim to be able to produce steel of any required composition and characteristics with equal exactness by the Bessemer process as by the Siemens. There can be but little doubt that much can be done in this way by the Bessemer process where the work is systematically and carefully carried on.

Notwithstanding the fact that phosphorus cannot be eliminated in the ordinary Bessemer converter, enormous quantities of steel have been made by this process, and within the last two or three years means have been devised by which this bugbear of steel-makers has been overcome. I refer to what is known as the Thomas-Gilchrist or "basic" process.

In the ordinary Bessemer converter the lining is formed of gannister, a silicious material. Now, silica has a greater affinity for oxide of iron than phosphoric acid has, consequently so long as free silica is present phosphoric acid cannot remain in combination with oxide of iron; while, then, the lining of the converter was of silica it is sufficiently obvious that phosphoric acid could never be eliminated.

You will at once say, Why line the converter with this objectionable substance? The answer is easy—no substitute was known, and the reason why phosphoric acid was not removed was not generally understood.

This was the state of things when Messrs. Thomas and Gilchrist commenced their experiments. The object they had in view was to substitute for the gannister a basic material, such as lime. The difficulty they had to contend with was to obtain a lining which would hold together. After many failures and much patient labor, a material has been found which fulfills the necessary conditions. This material is magnesian limestone; by grinding it and mixing it with pitch, bricks can be formed, which, after burning, are very refractory. In lining the converter it was impossible to cement the bricks satisfactorily together; they generally get a good deal curved in baking, and fit badly together, and the cementing material is easily washed out by the molten metal. In order to get over this difficulty, the converters have been lined by running the material in, and then drying and heating in stoves the various pieces of which the converter is composed. This method has proved to be more successful.

From an enemy, by judicious treatment, we may be said to have converted phosphorus into a friend.

In the acid process, it is essential that about 2 per cent. of silicon should be present, for it is, to a great extent, due to the presence of silicon that the requisite high temperature can be obtained. In the basic process, the less silicon there is the better; because it destroys the lining by fluxing it away. Here it is that the phosphorus befriends us, for it, too, is capable of producing a high temperature by combining with oxygen; and that being the case, it becomes

possible to work with about half the silicon necessary in the acid process, which practically means that we may employ a much lower grade of iron; for the lower the grade of iron, the smaller will be the amount of silicon in it.

So appreciated has this hitherto despised substance become, that it is actually the practice to put back into the blast furnace a great part of the slag from the converter, in order to increase the amount of phosphorus in the pig iron subsequently to be converted into steel.

There is, however, a limit to the lowness of grade of iron which can be used, for, although the silicon decreases, the sulphur increases, and only about half the sulphur present in the pig iron can be removed in the converter. One-tenth per cent. of sulphur suffices to prevent steel from rolling in a sound condition. As I have already pointed out, the way to counteract the influence of sulphur is to employ manganese in sufficient quantity, but this is not without a drawback, for manganese is expensive.

In working out this process, much difficulty was at first experienced, owing to the mouth of the converter getting gobbled up, that is to say, stopped by projected slag. The basic slag, consisting as it does principally of lime, is very pasty. This inconvenience has been successfully got over by employing converters of the form shown on the diagram. It was predicted by many that the slag and metal would be thrown out of the mouth of this form of converter; but that has not been the case, and it is not improbable that eventually this shaped vessel will be universally adopted for both the acid and the basic process. Such is already the case at Messrs. Bolckow, Vaughan & Co.'s works, where, under the intelligent and persevering guidance of Mr. Windsor Richards, the basic process has first been made a commercial success in this country.

One word as regards the silicon, which, we have seen, is useful as a combustible in the Bessemer process. This substance produces both red and cold shortness in steel, which has to be worked, if present, in even so small a quantity as two-tenths per cent. But in the production of sound steel castings, it has been found to exert a very beneficial influence by preventing the metal from becoming honeycombed by escaping gases while solidifying. It exerts its influence by combining with oxygen, which would otherwise unite itself to carbon and form a gaseous compound; the silica thus produced passed rapidly into the slag in combination with manganese, which is introduced at the same time as the silicon in an alloy containing them both.

In consequence of the extremely high temperature which we can command, either in the Bessemer or open-hearth processes, it is possible to obtain in a molten state metal practically free from carbon, or containing carbon to any required amount. It is sufficiently obvious that, having regard to the original and commonly understood meaning of the word steel, some other name should, strictly speaking, be applied to a metal manufactured by these processes, which cannot be hardened and tempered. In practice, however, there are many obstacles in the way of this being done, and it has become customary to designate by the term steel all the metal which has been produced in a molten condition by the Bessemer or open hearth furnaces.

It thus has resulted that we speak of steel ships, steel boilers, and steel rails. The metal of which ship plates are made contains about thirteen one-hundredths per cent. of carbon, that for boilers about twenty-four one-hundredths, while rails usually have about four tenths. The first and the second could not be appreciably hardened, and the third is considerably below what would formerly have been considered steel.

Although, then, metal possessing the true characteristics of steel can be made by these processes, yet that which is ordinarily made is not steel, but a metal called into existence by our recently acquired power of obtaining an extremely high temperature.

This new metal, as we may fairly call it, has properties far exceeding those of wrought iron, and it has only been a question of time to make this universally felt.

At the present moment new iron rails are things of the past, and wooden sleepers have begun to follow in their wake, it having become apparent to all that our new metal will be an economical substitute. So with ships, the wooden walls of old England are no more. Steel has not only supplanted wrought iron where it was used, but the wood also.

At present there is but one sound reason why steel should not universally replace iron with advantage, and that is, that in some cases it is cheaper to employ iron. Statistics show us that the enormous quantities of steel now manufactured have but little, if at all, affected the production of wrought iron. It is, however, I am convinced, but a question of time. When the day comes, and every day brings us nearer to it, when steel will be manufactured as cheaply as iron, then will wrought iron be a thing of the past among the great civilized nations.

One word as regards the employment of steel made by these modern methods for cutlery. Cutlery manufacturers would tell you that it is useless for the purpose; nevertheless, on the Continent, it is very largely used, and in this country to a considerable extent. I do not hesitate to assert that, with suitable ores and proper care in the manufacture, steel well suited for cutlery can be made both in the open-hearth and the converter. The essential in the ore is that it should not contain phosphorus; with but a trace of phosphorus present, a good cutting edge could never be obtained.

I have endeavored to show you this evening in what progress has really consisted, and how it has been brought about. If we glance back for a moment, we see that the open-hearth processes embody the same principle as the first process by which steel was produced, viz., the mutual action of carburized iron and oxide of iron on one another, and the Bessemer process is, after all, though a splendid offspring, only the natural descendant of the finery process, the origin of which, as we have seen, was due to modifications in the primitive blast furnaces. There is perfect continuity throughout, and, after all, what more natural? Progress in the art of manufacturing steel has been the joint work of the scientific chemist and the engineer. As in the past, so in the future, success will depend upon these two elements working harmoniously together.

THE company organized at Perth Amboy, N. J., recently for the purpose of supplying the city with the needed water-works is pushing ahead the work on the reservoir as fast as possible. A fine brick building is being erected near the new reservoir, which will contain the immense pumps and the powerful engine of the company. The daily capacity of the works will be over 3,000,000 gallons. The force will be so great that five streams of water can be thrown at once over the tallest building in the city, thus giving ample security from fire without the use of fire engines.

THE FLIGHT OF BIRDS AND THE MECHANICAL PRINCIPLES INVOLVED.

By A. C. CAMPBELL.

The flight of birds has always been a favorite subject of investigation, and the conclusion has ever been that it is a feat of great strength.

The apparent ease and the swiftness with which the bird moves through the air cannot have failed to excite a spirit of wondering in the mind of the acute observer. How does he contrive to sustain himself against gravity, and how is it that he can acquire such great speed by means of the appliances at his command?

Are there not some hidden mechanical principles involved in his flight that lighten his task?

Before endeavoring to give the philosophy of flight, we will consider some of the mechanical effects and properties of the atmospheric air as a medium through which the bird wings his way.

The air, as we know, has weight, and so it has inertia. It has perfect elasticity. Air in motion imparts its inertia to any object impeding its movement, and so arises what is understood as the force of winds.

It is a known law of winds that their pressure or force varies with the square of their velocity. Winds having velocities of 7, 14, 21, 41, 61, 83, and 99 miles per hour exert pressures respectively per square foot of 0.2, 0.9, 1.9, 7.5, 16.7, 30.7, and 37.9 pounds. From which we may conclude that a plane surface of five square feet, facing a wind of seven miles per hour, would receive a pressure of one pound. And the result would remain the same if the plane were moved at the rate of seven miles per hour against the air at a stand-still. Five hundred square feet, in like manner, would support a weight of one hundred pounds and descend through the air at a rate of seven miles per hour.

Now if the plane be inclined to the direction of the wind or force of air, there would seemingly be a twofold diminution of pressure: namely, in the first place, by a less proportion of air being intercepted; and secondly, on account of a less proportion of pressure being imparted. But in practice it does not hold true, since all of the particles of air are not turned sharply in a direction parallel with the plane.

After making many attempts to discover the relative pressures upon planes of variable degrees of inclination to the direction of the force of air, I finally hit upon the following simple device which gave very good results. I constructed a balance in such a way that the wind would take effect upon two plane surfaces of variable areas, and situated at variable distances from the fulcrum.

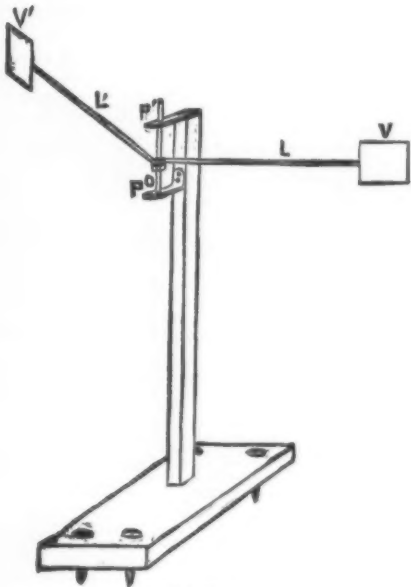


Fig. 1.

In the adjoining figure (1), VV' are the two planes fixed to the lever arms, LL' the latter being firmly fixed to the spindle, O , by binding screws. The spindle revolves in a socket made in the lower lip or plate, P , and passes through a small hole in the upper plate, P' . The spindle has perfect freedom of movement and is nicely balanced.

If both planes are the same area (say ten square inches) and both arms the same length, then there are two positions of equilibrium (supposing, all the time, that the plane, V , stands at right angles to the direction of the wind), namely, when both planes are at the same angle and when V stands at an angle 30° with the direction of the wind. In other words, if A and A' represent the angles which V and V' make respectively with the wind, then there is equilibrium when $A = 90^\circ$ and $A' = 90^\circ$, also, when $A = 90^\circ$ and $A' = 30^\circ$, and this appears to hold true for variable pressures of wind. If A' is made greater than 30° the pressure upon V preponderates until the angle of about 42° is reached, when the pressure is at its maximum. As A' is made less than 30° the pressure upon V preponderates.

The relative pressures upon the two planes, when A' is variable, may be discovered in two ways, namely, by adjusting the lengths of the lever arms until equilibrium is attained, when the pressures would be expressed by the proportion $P : P' :: L : L'$. Likewise if the arms are retained constant and equal, and the area of the planes made variable, then the following proportion would answer, $P : P' :: S : S'$, P and P' representing pressures per square foot, and S and S' the areas of the planes.

The following are a few results from actual experiment: I fixed a plane of ten square inches at V and the same at V' , then adjusted the arms at various angles, and moved the plane V along the arm L until the instrument balanced with the plane V standing normally to the wind.

$A = 90^\circ$	$L = 19$ inches.
$A' = 30^\circ$	$L' = 19$ "
$A' = 40^\circ$	$L' = 15$ "
$A' = 49^\circ$	$L' = 14.5$ "
$A' = 45^\circ$	$L' = 10$ "

Retaining the arms at a given length and equal, the following results were obtained:

$V = 10$ sq. inches.	$A = 90^\circ$
$V' = 10$ "	$A' = 30^\circ$
$V' = 9$ "	$A' = 20^\circ$
$V' = 6$ "	$A' = 15^\circ$

If a plane surface of one square foot be moved normally against the air at the rate of 31 miles per hour, the pressure or resistance would be 1.9 lb. If the plane were inclined at an angle of 30° with the direction of its movement, the pressure would remain the same, but the buoyancy against gravity would be expressed by $1.9 \cos. 30^\circ = 1.64$ lb., while the horizontal resistance would be $1.9 \sin. 30^\circ = 0.95$.

If the plane be inclined to within 15° of the direction of movement, it will receive a normal pressure of $\frac{1}{2}$ of 1.9 lb. = 1.14 lb., $1.14 \sin. 15^\circ = 0.295$ lb., $1.14 \cos. 15^\circ = 1.1$ lb. As the plane becomes nearly parallel with the direction of the force of air, a less proportion of it is intercepted and imparted, but as much as is received by the plane, the greater part gives an upward buoyancy, while a very small horizontal resistance is offered. If it be inclined to 5° then the proportion would be horizon. resis. : vertical buoyancy :: 1 : 11.43.

A bird in his flight moves against the air with such velocity that he needs to make but little effort to sustain himself against gravity, so allowing the greater portion of his strength for propulsion.

A plane moving horizontally through the air, and with such velocity and inclination that the component of the lifting force is equal to the force of gravity, then it will continue to move in the same horizontal direction. And we may say, generally, that a plane moving in any direction will continue to move in the same direction, provided, always, that the component of the force of air at right angles to the path, and the component of gravity also at right angles to the path, are in equilibrium. The component of gravity parallel with the path will accelerate or retard as the plane is inclined downward or upward.

Velocity is power or advantage by whatsoever means attained, whether by force of gravity, by force of air, or (in the case of the bird) by muscular effort. A bird moving against a wind derives a twofold advantage, namely, from the combined velocities of the wind and his bodily movement.

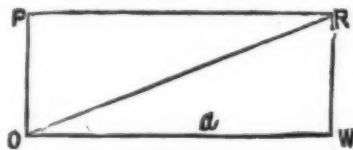


Fig. 2.

Some strange effects of the force of winds arise from combined movements.

Let WO (Fig. 2) represent the velocity and direction of a wind, and OP the velocity and direction of a plane maintaining a position at right angles to its path. Let $a = 30^\circ$. It is evident that such combined movements are equivalent to a movement in velocity and direction marked by OR , supposing the air at a stand-still. But it has been demonstrated by experiment that a plane, holding an angle of 30° with its path, receives the same normal pressure as when at an angle of 90° .

$OR = 2 PO$, and the pressures, being in the ratio of the squares of the velocities, would be as 1 : 4.

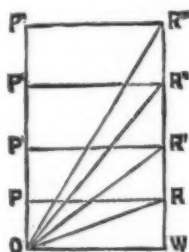


Fig. 3.

The angle a and the directions OP and WO may vary, yet the demonstration will hold true, provided the correct value is known of the normal pressure upon the plane at the angle a to its resultant path.

The vexed question of the ice yacht comes under the head of combined movements. Let WO (Fig. 3) be the velocity and direction of a wind taking effect upon a plane occupying the position OR , and a the angle between WO and OR . Let OP be the path of the plane.

It matters not whether the wind move against the plane, or the plane move with the same velocity against the air at a stand-still. It is evident that if a plane move parallel with itself it will encounter no resistance of air. Passing from O to R is the twofold movement OW and OP . But WO is the velocity and direction of a wind which, when substituted for the movement of the plane, makes it equivalent to the plane moving from O to P in the same time that the air passes from W to O . Likewise with OR , OR' , OR'' , OR''' , etc. Every possible case may be referred to the parallelogram and demonstrated in like manner, remembering that the pressure is at all times normal to the surface of the plane.

A plane at an angle of 30° with the direction of a wind receives the same pressure as when at 90° , but if R represent the velocity of wind, $R \sin. a$ would express the velocity with which either plane would move in a direction perpendicular to the plane, supposing no resistance. $R \sin. 30^\circ = \frac{1}{2} R$.

If the inclined plane move with the wind, of course the velocity would be the same as that of the wind, but the pressure tending to urge the plane in that direction would be one-half of that taking effect upon the normal plane, which is as it should be, since only one-half as much air is intercepted by the inclined plane.

A force of air coming in contact with an inclined plane is turned with the plane, and so long as the force continues there is a stratum of air passing down and parallel with the surface, and the constantly approaching air, instead of coming in contact with and imparting its force directly to the

plane, encounters and imparts its force to a belt of air; so the initial force of air is resolved into a force of pressure of an elastic medium acting at all times normally to the surface.

Each and every particle of air having a certain quantity of accumulated energy will impart its full effect of pressure, either directly or indirectly, gradually or abruptly, provided such particles are turned, on account of the plane, more or less from their initial direction.

They may impart their effect directly by coming immediately in contact with the plane, or indirectly by imparting their pressure to other particles, and they in turn to others or a series of particles.

They may impart their effect gradually by a gradual change of direction, or abruptly by an abrupt change of direction. The quantity of pressure imparted by every particle is dependent upon the degree of change of direction.

It is a principle of mechanics that any force or forces will seek paths of most ready relief, and the principle should hold true in the case of a force of air intercepted by a surface.

A particle may begin to change from its initial direction at some distance before reaching the plane, and altogether there would be a system of arrangement and movement of the particles, arising from the pent up forces seeking paths of least resistance. After the system has become thoroughly established there is a constant minimum pressure imparted to the intervening object.

If a surface be brought instantly into cross section with a force of air, there will be an impulsive force imparted from the suddenly arrested movement of the column of air intercepted. From this there will arise a compression of air until its inertia permits it to escape from the surface and establish the system of movement referred to. The pressure is greatly augmented, but of short duration.

We will suppose a flow of air to be passing through a long tube.

Now, if the discharging end be suddenly closed, the air coming in contact with the closed end will impart its inertia at once, while the air throughout the length of the tube will continue to move, but with a diminished velocity. The particles nearest the seat of pressure will be more rapidly impeded, while those more remote will suffer only a gradual retardation. At the instant when the entire column is at a stand-still, and possessed of an equilibrium of forces, then there will be a maximum of pressure at the closed end, with an arithmetical diminution of pressure toward the inlet. There will be a gradation of pressures along the sides of the tube, the same as the compression of air throughout its volume.

Now it is evident, if the air were not confined by the walls of the tube, that a lateral movement would take place in the direction of the strongest pressure, having to overcome the inertia of the air moved. This lateral movement would not only be that in line with the opposing surface, but also that extending in all directions, acting as walls in a degree like the walls of the tube.

The moment the air is intercepted that portion in contact with the surface makes the first move to escape, because of the excess of pressure brought to bear upon it. Then follow in succession portions of air more distant.

In the bird's flight it is an object to prevent this too hasty escape of the compressed air, so that more energy may accumulate and impart its effect. A force of air encountering a rigid or irresistible surface is turned from its initial direction on the slightest increase of pressure; but if the surface be elastic, or to a degree non resistant, then the first imprint of pressure will be received and held in suspense by the receding parts of the surface until the more distant particles of air have arrived and added their burden of energy.

The density of air varies with its pressure, and its inertia increases with its density, so that when the pressure is augmented it has greater persistency against the tendency to a set movement of escape. Again, the opposing surface may be of such nature in its elementary parts as to obstruct the lateral escape by a species of entanglement of the individual particles of air and their inertias.

Air is possessed of a physical property (that of cohesion) which is of vast worth in its relation to our problem. All varieties of matter are possessed of cohesion in greater or less degree. The different degrees of cohesion give rise to solidity, plasticity, and viscosity. All solid or rigid substances, so called, are more or less plastic, and all liquids and gases are more or less viscous. Under the effect of impulsive forces, plastic substances are as if solid, and viscous substances are as if plastic.

The air in effect behaves as a solid when subjected to impulsive forces of greatest intensity. A case in point is the explosion of nitro-glycerine upon the surface of a solid. The mass is ruptured into fragments as if struck by some heavy weight. After the shock the air relieves itself as rapidly as the friction of cohesion and inertia permit.

Work in its mechanical sense is made up of two factors, namely, mass and velocity. $W = \frac{1}{2} M V^2$ is the most general expression; W is the quantity of work, M the mass or quantity of matter, and V the velocity with which it is moved.

Then it will appear, from all that has been said, that the work of velocity, rather than the work of mass, is the most advantageous source of relief in the bird's every effort. By whatsoever means he may attain velocity, he secures a corresponding relief of duty, and every move of increased velocity given to his wings in opposition to resistances is likewise an economy of power; an increase of velocity permitting a decrease of area of wing, so affording a relief of work. We must avoid the idea that there is of necessity a certain quantity of work for the bird to do, and that he can by no means avoid the set task.

The bird strikes downward with his wings, and secures a pressure of air, which he manages to retain by defeating its every effort to escape. At first his wings decline to the rear, but owing to their torsion and flexure the increasing pressure of air finds relief only through a circuitous path, and at the completion of the stroke the extremities of the wings are tilted rapidly upward.

The wing is so strangely constructed, and its parts are so well adapted to the uses for which they answer, it may be well to study it in detail. It will be necessary to make a few practical demonstrations in order to do our work understandingly.

Let a, o (Fig. 4), be a series of elastic surfaces, b, b', b'' , etc., and each one confined by its upper edge so that a force of air from the direction denoted by the arrows will cause the surfaces to revolve and close the passages, c, c', c'' . This done, the air is defeated in its movement, and a shock or force of impulse secured.

If, instead of the free movement of the slats, they be supposed to have an elastic resistance against being closed, then a force of air of variable intensity will cause them to open

and close in rapid succession, as the force and resistance alternately hold sway. The slats having weight, their inertia in the to and fro movement would act an important part in timing the vibrations to the degree of pressure, and there would be a rhythmical play of impulses or pulsations. Another demonstration may serve to give a more accurate idea of this force of impulse.

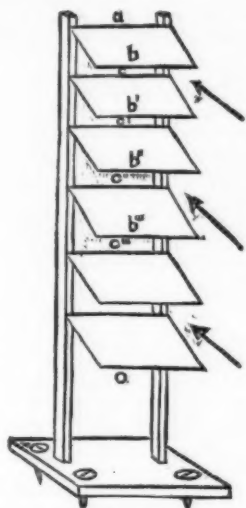


Fig. 4.

Let *a'o* (Fig. 5) be a plane surface moving adrift with a wind of any velocity, the plane having the same velocity as the wind. There can be, as yet, no interference. Let *d* be a fixed point of resistance. The plane will continue to move until it arrives at *d*, where it will be instantly stopped.

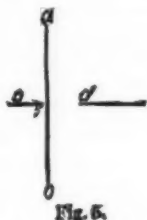


Fig. 5.

ped, thus causing the intercepted column of air to be as quickly stopped and deprived of its moving force. There would be an arrested movement of the air on the two sides of the plane; the difference of the two pressures would be the effective pressure.

So far we have only looked to the force of air as taking effect in one direction, but in the bird's flight there is requisite a lifting and a propelling force.

A force of air after having imparted in one direction a pressure due to its living force may yet impart another pressure in another direction without losing any of its accumulated energy, provided it imparts no movement.

When the bird strikes downward with his wings the resistance of the air acts upward, thus supporting his weight, and also giving him a forward impetus, owing to the escape of the pressure of air to the rear.

The wing, as is well known, is made up of long, stout feathers with quill extremities inserted in cartilaginous sockets of the bird's arm. These quill extremities have muscular attachments, so that the bird has power to revolve the feathers within their sockets. Each feather is made up of a midrib extending through its entire length, the quill or socket extremity of which is tubular, rigid, and larger than the balance. It is translucent, horny, and tough, well calculated for strength, and, at the same time, lightness. The balance of the midrib is pithy and not so rigid. It grows smaller and much lighter toward the point. Radiating from both sides are feather branchlets and sub-branchlets, which, from their close proximity, give the feather a smooth surface-like appearance.

Supposing the bird's wing outstretched, with the quill feathers pointing to the rear. The branchlets that radiate inwardly toward the bird and *underlap* form a more extensive surface than the branchlets of the opposite side of the feather, which *overlap*. The lapping may be of position, without contact, the bird having power to adjust the feathers.

Supposing the surfaces to be properly adjusted, then, as he strikes downward with his wings, a force of air, taking effect upon the overlapping surfaces, causes them to collide with the overlapping surfaces, thus abruptly stopping the initial movement of air and its initial energy. This momentary shock or impulse given to the wings serves as a foothold to sustain the bird against the tendency of gravity, and as the strokes are made in rapid succession, he may be said to walk upon the air.

The compressed air may seek relief by passing along the surfaces of the wings and escaping from their extreme margins, after having yielded its store of energy first to sustain and then to propel. Or it may find more ready relief by penetrating the network structure of the feathers.

Of these two channels of escape the latter one is sought by those particles of air that come immediately in contact with the wing-surface at the instant of the shock, and are the most active and are possessed of the greatest energy. If permitted, they would destroy the vantage-ground by generating a radial movement of escape. Hence the strangely beautiful structure of the feather.

The pressure of air is first caught, directed and manipulated by the branchlets, and then by the sub-branchlets, when it is allowed to escape from its entanglement. These sub-branchlets radiate from the branchlets, the latter being as midribs. These secondary midribs are discoid in section, and have a tough horny exterior with a pithy center. See Fig. 6.

b, b', etc., are the branchlets or secondary midribs, on each side of which are the sub-branchlets *c, c', etc.*, etc.,

overlapping, and *d, d', d''* underlapping. The former are longer and more prominent, and the latter form a much less aerial surface. These sub-branchlets have their lateral borders barbed with little hooks or loops that enable the over and under lapping surfaces to cling together, and they hold with a persistent grasp so long as the surfaces are in contact.

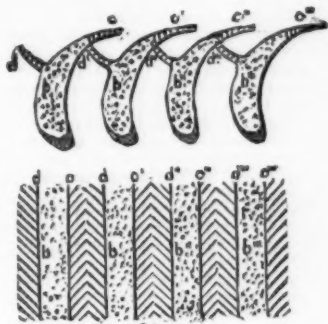


Fig. 6.

From the character of these different parts of the feather and their arrangement with reference to one another it is evident that the elastic force of air taking effect upon them causes a rhythmical vibration, each and every part securing a series of rapid pulsations.

An average feather has about one thousand branchlets, and one million five hundred thousand sub-branchlets, each one of which lends a helping hand to lighten the bird's task. In proportion as there is a greater percussion, the rhythmical pulsations are more frequent and stronger. In the flight of the pigeon and of some other birds this rhythm gives rise to a musical whiz.

So far we have only mentioned the bird proper, and there are almost an infinity of creatures of flight, and one of the most humble is the bat.

The bat, in lifting his wings, raises the front margins more rapidly than the balance of the wing, so that a downward turned fold is given to the thin elastic membrane. At the completion of this fold or loop he thrusts his wing downward, so that the body of air is brought to impinge upon its convexity, suddenly reversing it and bagging the force of air.

I tried the following simple experiment to demonstrate the character of this force. The arm, *c d* (Fig. 7), is made of dry hickory and tapers toward *d*. *b d* is a ring or hoop firmly attached to *c d*. *c d* is mortised with glue to a thick and heavy block of wood. The hoop is covered with a loosely fitting membrane, or paper.

To make the experiment it is only necessary to pull the spring, *c d*, in a direction normally to the surface of the membrane, and then "let fly." The sudden impact of air against the surfaces of the membrane gives two loud reports, the second or reactionary stroke being louder and consequently the stronger. Stout paper may be easily burst by the impact, the report being like that of a pistol.



Fig. 7.

The experiment may be varied by substituting wire gauze for the membrane, and suspending tissue paper before and at a distance from the hoop. The gauze offers little resistance to the movement of the spring, but is greatly impeded by the thin paper on account of its imperviousness to air. In this case also a loud report is given, which is proof of great concussion of the air.

It may be proper to say something of the little fly. How does he accomplish such wondrous bodily movements, his wings being so light and delicately slender? It cannot be discovered that he has much power of muscle, and yet it does seem that he must needs make considerable effort to overcome the inertia of his weight in his rapid starts from rest.

It has been shown that in proportion as the air is acted upon more quickly does it exercise greater resistance, and that in proportion as any winged creature strikes the air more quickly, may his wings be smaller and the actual work lessened in great degree. So we may conclude that the fly profits by the rapid movement of his wings. And that such is the case we may be further convinced by recording the musical note sounded by his wings. Knowing that they must move with great velocity, we must conclude that they do not move normally against the air, but rather at an angle, cutting the air upward, downward, and laterally, the torsion of the wings and their delicate elasticity regulating their angular inclinations, and they are as if smaller under increased velocities. His wings are so exceedingly light that he needs make but little effort against their inertia. Besides, if they move through curvilinear paths without undergoing accelerated and retarded movements, then is the inertia continuous and self-sustaining.

In conclusion we may say that flight, whether of the bird, the bat, or the fly, is not the herculean task of our wonted belief, but rather one of pleasurable ease, unaccompanied by the impediments that clog the way of the creatures that plod the earth.—*Journ. Frank. Inst.*

CORN CULTURE IN MASSACHUSETTS.

We are indebted to Dr. E. L. Sturtevant for a copy of an interesting and valuable pamphlet of 130 pages, containing his address on "The Growing of Corn," before the Massachusetts Board of Agriculture, and a full report of the discussions which followed on the various points treated in the address. Dr. Sturtevant has for several years given special attention to this subject, and has submitted various scientific views to the test of practice. The address is full of suggestions in connection with the results of experiments, and with a very few exceptions his views commend themselves to the assent and approval of intelligent cultivators. The subject is treated under the general heads of history of varieties, improved seed, preparing the land, fertilizing, planting, cultivating, harvesting, and management of the fodder; and the general results reached for securing large and profitable crops are: 1. Obtaining seed of a prolific variety; 2. shallow plowing and deep pulverization; 3. medium surface manuring; 4. early and rather thick planting; and 5. thorough cultivation solely by horse labor; while (1) poor or unknown seed, (2) too little or too much manure, and (3) hand labor are to be avoided. Among the experiments mentioned by Dr. S., we quote briefly the following, performed by Prof. Stockbridge, to show the influence of cultivating the soil. Boxes of a cubic foot capacity were filled with undisturbed soil. Those which had the surface hoed lost by evaporation 900 pounds from clay soil, and 540 pounds from light soil; but unhoed, the clay gave off 1,170 pounds, and the light soil 1,276 pounds, showing the retentive influence of surface cultivation. But where deeply pulverized in the boxes, twice as much water escaped from the light soil, and four times as much from the clay, as a consequence of the deep tillage. The surface hoeing doubtless left that portion in a finally pulverized condition, operating as mulching; while the deep stirring opened many crevices for the escape of moisture. Dr. Sturtevant experimented on the value of corn fodder as fed to his herd of cows, and found that every ten tons were equal to six tons of hay. He sold his hay at \$22 per ton at the barn, which gives the corn fodder at \$13.20 per ton. With his close planting in drills, he obtains about four tons per acre, which is equivalent to two and four-tenths of hay. Special pains are taken that the fodder is not injured by rains. He has seen corn fodder in the neighborhood not properly protected, which he would think not worth \$3 per ton.

The discussions which followed the address were full of interest and valuable information, and the diverse views of several eminent cultivators were fully given. Ex-Gov. Boutwell said that corn-raising could be profitable in Massachusetts only when cattle could be employed to consume the fodder. From a field of sixteen acres he obtained twenty-four tons of fodder, which he had proved worth \$10 a ton, leaving the cost of the grain at 22 cents a basket. The fodder is cut an inch long with a power machine, put in a tight box, meal added, and hot water poured on, and left twelve hours. His thirty cows fed with this fodder give as much and as good milk as when fed on hay. He sells a ton of good hay for every ton of corn-fodder that his cattle eat. His best cow gave last year 9,600 pounds of milk, and five cows averaged 7,800 pounds, which he mentioned as a proof of the quality of their food. Mr. Emery, of Lowell, had found that steaming had rendered fodder unpalatable to his cows, and they would not eat it readily; but when cut and treated with cold water, they devoured it freely. The steam appeared to generate some offensive taste. He did not agree with Dr. Sturtevant (who fed the stalks whole) that the leaves and sheaths of corn fodder contained nine-tenths of the value of the whole, and in cutting it an inch long so that all would be eaten, he found the value increased at least 25 per cent.

Mr. Cushing, who supplies milk to the Boston market, had experimented with feeding alternately each week corn fodder and English hay, and was surprised that he could perceive scarcely any difference—frequently there has been no difference—in the quantity of milk. He feeds the stalks whole. He suggested the experiment of feeding whole and dry, then changing to the same quantity wet, and again to the same quantity cut and steamed—taking into the account the cost of the cutting and steaming apparatus. Mr. Hadwen, of Worcester, said that when hay was worth \$15 per ton, well saved and well cured corn fodder was worth \$10 a ton.

The cultivation of the crop received a portion of attention. Capt. Moore said when he visited Dr. Sturtevant's farm, he saw some weeds growing in the rows of corn (not between them), and inquired, "Why don't you dig up those weeds?" Said he, "I have gone just as far as profit will warrant me in raising that crop." Capt. M. said that the weeds on an acre could be pulled out in half a day, and he was sure they made a difference of five bushels in the crop. The next year the labor of keeping them down would not be half as much. Mr. Bowditch disliked weeds as much as any one, and yet for the past few years he has made it a rule never to allow a hand-hoe to go into his corn field. He never had a cleaner field than the past summer, and he did not think there was a cleaner one within ten miles, even weeded by hand. He did the work with a new horse-hoe, made with three disks on each side, which could be set at any angle. Reversing the wheels the earth may be thrown away from the drills, and you can ride over corn a foot and a half high. The earth could be thrown over any young weeds between the plants. He plants with a Western machine called the "Climax Planter." It puts in an acre an hour, and his seventeen-acre field was planted in seventeen hours; it drops two rows at a time. The wheels are concave, filling in the earth directly over the corn, and pressing it down so hard that it is impossible for the crows to pull up the plants. It has been used three years, and in that time many crows have been seen pulling away after the corn was up, but they would only nip the tops off. They did not get up a single kernel. Mr. Hersey had made it a rule not to allow weeds to grow on his land. He once visited a farm in New Hampshire, which the owner had occupied fifty years. He looked it over, and could not find a single weed among the cultivated crops. All seeding was prevented and the land cleaned.

As a proof that the speakers at this discussion gave the details of successful practice, we observe that the measured crops of shelled corn, which they reported as having raised often, ranged variously from 80 to 105 bushels to the acre.

We have given a brief outline of some of the discussions, for the purpose of inviting attention and experiment to certain points which as yet have received only random estimates on the part of most cultivators, where more accurate tests are needed. The pamphlet from which we derived this information constitutes a portion of the Twenty-eighth Annual Report of the Secretary of the Massachusetts State Board of Agriculture.—*Country Gentleman.*

PLANTING FOR PROFIT.

At the recent summer meeting of the Michigan State Horticultural Society, Mr. T. Mason, of this city (who has had a large experience in handling fruit), read a paper in which the varieties of fruit of various kinds are given that are sought and readily disposed of at the best prices in the market. We take the following extract from his paper:

The chief requisites in all fruits for market purposes are firmness, color, quality, and size, in the order named. Let me open with the apple: a bright red is the most popular color, hence Steel's Red, Wine Sap, Willow Twig, Jonathan, Baldwin. Even the Ben Davis is preferred to a better apple of a poor, dull, or rusty color. Take the Baldwin, when it is of a bright color, it will sell at fifty per cent. better price on the same date than when it is shown of a dull color. There are many points to be considered in relation to the profitability of certain varieties, even when the best qualities in their best color are presented on the market, which our Michigan fruit growers should consider. Take the Red Astrachan, for instance, with its beautiful high color, its superb flavor, that certainly should, according to my showing (as to color at least), prove a profitable market variety; but such is seldom the case with us, for the reason that our market in its season is so well supplied with other varieties of fruit, also with a full supply of apples from Southern Illinois that are better shippers; consequently the Red Astrachan has to be sold low on its arrival when received in large quantities, as we dare not hold, its fine texture tending to rapid decay. Michigan may boast of its ability to raise and market apples of the best variety and in the greatest perfection, as to flavor and keeping qualities, of any State in our Union, therefore our aim should be to plant the best shippers, as the time is not far distant when the exporters of apples will look to Northern Michigan as their source for supply.

Among the varieties I would consider suitable for profitable planting are the Baldwin, Steel's Red, Willow Twig, Spitzenburg, Wagner, Newtown Pippin, Jonathan.

Next in order would be the Pennock, Greening, Spy, Bullflower, Maiden's Blush, Red Astrachan, also the Ben Davis, Seck no further, Snow, Golden, and Rox Russet.

I would not be understood as limiting the list of varieties to those mentioned, but rather as types of the varieties called for most in market. You may wonder why I speak of the Pennock; it is often required for shipment to Southern points, as it will stand the climate better than our softer varieties, hence for that purpose salable.

The apple list would not be complete without naming at least two Crabs—the Hyslop and Transcendent are at the present time most salable of all the crabs, the Hyslop proving the most salable from the fact that Transcendent comes on our market too early for the demand, hence the Hyslop proves more profitable.

I shall not attempt to go through the list of pears, but would say at present, and probably for the next generation, the Bartlett takes the highest rank as a market pear, and more of that variety can be profitably disposed of than all the other varieties put together. Clapp's Favorite, Flemish Beauty, Seckel, Louise Bonne, and Duchesse d'Angoulême are among the most salable on the long list of pears.

The Black Tartarian is the most salable of all sweet cherries, with the Early Purple Guigne, Gov. Wood, and Napoleon Bigarreau following closely, with Early Richmond and May Duke as the leading sour or cooking cherries.

Pears.—The Lumbard, Washington, and Green Gage for dessert, with Wild Goose for cooking.

Peaches.—The yellow flesh varieties have their preference over the white, such as Crawford's, Jacques' Rarierpe, and Smock's Free, with a notable exception in favor of the old Mixen, one of our best shippers.

Grapes.—The Concord and the Delaware are the market grapes par excellence.

Currants.—The cherry takes the lead.

Red Raspberries.—The Brandywine is the best at this date, for late, with a new berry. Reeder's Seedling for early. Next comes the Kirthland or Highland Hardy, with the Herstine and Turner, the latter proving not of sufficient firmness for reshipment.

Black Raspberries.—Doolittle, Miami, and Mammoth Cluster.

The strawberry being produced in the largest quantity of all our market berries, I feel it proper to occupy more time on this fruit. Therefore, I propose to give you a list of varieties that have come under my personal observation, and pronounce on their merits solely in their relation as shippers to the Chicago market. I shall name them in their alphabetical order:

Varieties.	Color.	Flavor.	Shipping Qualities.
Agriculturist.....	Crimson.	Good.	Near market.
Boyden (Seth).....	Dark red.	Sweet.	" "
B. Scurler.....	Scarlet.	Good.	Worthless.
Capt. Jack.....	"	"	Good.
Chas. Downing.....	Light.	Medium.	Poor.
Champion.....	Dark crimson.	Good.	Home market.
Crescent Seedling.....	Bright scarlet.	Poor.	Worthless.
Col. Cheeny.....	Light scarlet.	"	Near market.
Cumberland Triumph.....	"	Medium.	" "
Duchess.....	"	"	" "
Endicott No. 2.....	Dark red.	"	" "
Forest Rose.....	Bright red.	Good.	" "
Glendale.....	Dull red.	Poor.	Worthless shippers.
Green Prolific.....	Scarlet.	"	Near market.
Great American.....	Dark crimson.	Medium.	" "
Jucunda.....	Glossy.	Good.	" "
Kentucky.....	Scarlet.	Fair.	" "
Lenning's White.....	Light.	Best.	Too light in color.
Monarch of the West.....	Light scarlet.	Good.	Near market, too light.
Fres. Wilder.....	"	Best.	" "
Sharpless.....	Glossy red.	Good.	" "
Triomphe de Gand.....	Glossy scarlet.	"	Good.
Wilson's Albany.....	Scarlet.	"	" "

The last two named on the list should be placed first as to order of merit when viewed in the light of market berries, for the following reasons: First, the T. de Gand is the best of all the large varieties in combining all the requisites of a good shipping berry—size, color, flavor, and firmness.

Last, but not least, the Wilson's Albany, our old reliable and well-tried friend. With its color and shape you are all familiar.

In their eagerness to experiment with new varieties, I

fear many that are growing the Wilson for market are giving it but shabby treatment, not giving it a fair chance to show its good qualities; they do not give it as good a piece of land as they find for their corn patch; neither do they give it as careful cultivation. Let me ask you about the one or two dozen plants you have received by mail, at a cost of \$3.00 or \$5.00, or that some kindly disposed neighbor has obliged you with as a great favor. Do you take those plants and place them in the same field with your Wilsons? Oh, no; you place them in your garden, in the best prepared soil, and probably apply an extra dose of some fertilizer for your favored plants. So they are planted, hoed, and watered; being tended with care, it is to be wondered that your pets should reward you with a fine show of berries that throw your neglected Wilsons in the shade? You feel that you have "struck oil," so to speak, and plow out the Wilson and plant your field with your new pet and ship to market. With them you write your commission man that you send him a choice berry—a new variety, and that you expect a good price for them. Now, commission men, to be successful, must be good judges of human nature, think really more how they can hold your shipments than they do of abstract theories, endeavor to answer more with the view to please you than to give their honest conviction. The result is that you plant more of what really proves to be, with field culture, an inferior market berry. I say, next to the T. de Gand, the Wilson has no rival worthy the name up to this date, having all the requisites for a good market and shipping berry. It is the most salable strawberry known. Its shipping qualities for distant markets, its firmness, its color, its agreeable acid, make it one of the best for preserving or canning purposes, and by selecting a rich, moist soil, giving good cultivation, renewing your plantation every one or two years, you have in the Wilson all the requisites of a profitable market strawberry. A word of caution to the planter of new varieties for market purposes: You are apt to be misled many ways, the source of which may not have been intentional, but nevertheless affect your judgment; for instance, you have received 50c. or \$1.00 more for your fancy case above the market price of Wilsons, hence you hastily conclude had your crop all been of your present pet variety you would have realized so many dollars extra. Just there is where you err. I doubt if there has been any of the large sized old time "new varieties" that did not realize to the shipper a better price for a few trial cases above that paid for the general market berry of the day. Let me ask what has become of them? Why so many left so far behind in the race that their names even are lost to memory? and those that have appeared of more recent date, why have they lost the exalted position they once held in our estimation? Will these not surely follow in the wake of their predecessors if they do not prove to have the requisite merits already possessed by the Wilson? Allow me here to give an example: Let us take the Sharpless, one of our latest acquisitions, a berry that possesses apparently all the requisites of a successful cand date for popular favor; its large size, beautiful glossy red color, of fair sweet flavor, and moderately firm, give it promise of success. Presuming some at least of my hearers are growing and will ship of this variety, you without doubt will get a much better price for the few cases you will ship this season, and why will you not continue to do so? Among many, I will give this reason: There is a class of people in all our large cities with whom the price of an article is of secondary consideration to the gratification of their tastes or pleasure. That class will take of these firstlings, at an advanced price; you receive the benefit of such from your commission man; you judge from these returns that this is the coming berry, and plant all possible, and so does our neighbor, and by the time the field crop comes in, market having had a touch of the Wilson management, and you realize from their sales, you find you do not get as much net proceeds per acre as does your neighbor that shipped select Wilsons. You ask, Why? Let me say the Sharpless is not for the million, but for the millionaire, they being few in number comparatively, hence the berry for the million holds its sway, is sold with the first morning sales, and shipped to distant points at highest market rates; while your pet Sharpless, Monarch, Boyden, Downing, Jucunda, etc., etc., are left to the chance sale for a few of the best selections at a trifle above the Wilson, while the great bulk of them have to be forced off at lower rates to doubting buyers, and in a short time are neglected, so that our poorest class of peddlers will scarcely take them off the market, even at a great reduction in price below the Wilson. You repeat "Why?" I can answer: The chief cause of their disfavor lies either in their poor light color or their want of firmness, often both combined. You may say that is a matter of prejudice which can be overcome. How has it proved with the long host of pets of

loss should they have to carry any over to the next day, which they know by experience they can not do with any other variety. Should the Sharpless, one of the best of the newer claimants for public favor, both in color, size, and flavor, prove capable of superseding either the T. de Gand or the Wilson as a successful market berry, I shall be greatly surprised, for I do not at this date know of a berry capable of dethroning either the Wilson's Albany or T. de Gand from the proud position they have maintained so many years.

POULTRY CHOLERA.

A GOVERNMENT PAPER ON FOWL CHOLERA—ITS PREVENTION AND CURE—VALUABLE RULES.

THE Agricultural Department at Washington has issued, in advance of its publication in the annual report, the report of D. E. Salmon, D. V. M., on cholera in fowls, the results of an investigation made by him on this subject, and on account of its importance we herewith publish its material points. In spite of its virulence he thinks it can be controlled and extirpated with comparative ease. The points to be observed are:

1. *The virus is not diffusible.*—That is, the disease germs are seldom if ever taken up by the air and carried any considerable distance to produce the malady. The virus remains in the fixed form, and is generally if not always taken into the body with the food; it is distributed over the grounds, feeding places, etc., in the excrement of affected birds, and the food, drink, and gravel are thus contaminated. Healthy birds may be kept in coops within a few feet of the sick ones for months without contracting the disease; but if the former are now placed in the same inclosure with the latter, they sicken in a few days.

2. *The virus must be carried upon the grounds frequented by fowls before they contract the disease.*—It is not probable that this disease originates in any considerable number of cases in any other way than by contagion. There is a possibility that it may originate in occasional instances by filthy surroundings; if closely confined, or by feeding on decomposing substances; but there are few facts to support such a conclusion.

It is thus brought upon farms either (1) with sick or infected fowls newly acquired, (2) with the blood or parts of the bodies of dead birds carried on the feet of people or brought by dogs or other animals, (3) with infected manure or feathers, or (4) possibly by wild birds, animals (rabbits), or even insects that have contracted the disease or have eaten the blood or bodies of affected birds recently dead. The origin of the disease can generally be traced in country districts where houses are a considerable distance apart, to recently acquired poultry. It is only in districts more thickly populated, and then in exceptional instances, that the germs are carried by wild birds or animals or by insects.

PREVENTIVE MEASURES FOR GROUNDS ALREADY INFECTED.

1. *In the disease cholera?*—Fowls frequently die in considerable numbers from diseases that are not contagious, and hence it is a matter of primary importance to decide as to the nature of the affection when cholera is suspected. In my own experience I have found that this might be done with comparative certainty by inspection of the excrements. With fowls the excretions of the kidneys are joined in the cloaca with the undigested parts of the food, and both solid and liquid excrement are consequently voided together. They are not mixed to any great extent, however; the part excreted by the kidneys is easily distinguished, as during health it is of a pure white color, while the bowel discharges are of various hues. The kidney excretion will be hereafter referred to as the *urates*, and it is the only part which claims our attention.

After a fowl takes the contagion into its body, the first and only reliable symptom is a coloration of the urates. At first these have only a faint yellow tint, which rapidly changes, however, into a deep yellow color; up to this time the bird shows no other signs of the disease, its temperature is unchanged, and its excrement of a normal consistency. In one or more days after this yellow color appears the urates are greatly increased in quantity, and constitute the whole or a greater part of the discharges and an obstinate diarrhea sets in; in a few cases the urates now become greenish, and exceptionally they are of a deep green color.

The only lesion seen in post-mortem examinations that is likely to attract the attention of non-professional observers is the enlarged liver, which is nearly constant; it may be of various shades of color. Besides this the presence of yellow urates in the cloaca and ureters is a valuable sign and is generally present.

Sick birds must be destroyed.—The excrements of sick birds are the principal means of spreading the contagion, and the first step in stamping out the disease is consequently to destroy all which are voiding yellow urates. Care should be had to make the distinction between the urates and the bowel dejections, for the latter are frequently of a yellow color in health; but a little observation will preclude any mistake of this kind. The killing should not be by any method which allows the escape of blood, as this fluid is even more virulent than the excrement; wringing the neck is a quick and easy method of destroying the life. Once killed, the bodies are to be taken beyond the limits of the poultry run and deeply buried.

If it is decided to keep the sick birds till they die or recover, they should be placed in an inclosure by themselves, as far as possible from the healthy ones, where they may be cared for without entering, so that there will be no danger of carrying particles of the excrement on the boots.

3. *Healthy birds must be placed on disinfected grounds.*—If a piece of land is at hand to which the sick birds have not had access, and which is consequently free from the contagion, the healthy birds should be penned upon it; but if all the land is infected, then a piece is to be selected and thoroughly disinfected with the solution mentioned further on in this paper. The fowls are to be restricted to this disinfected ground for several months, or even a year or more if practicable. The drinking vessels and feeding troughs are to be new, or if used before they must be soaked for twelve hours with the same solution before being placed in the new inclosure.

4. *Observations to be continued to note the first reappearance of the disease.*—Some of the fowls, though well at the time of removal to disinfected quarters, may be infected with the disease, and after the period of incubation, which varies from three to twenty days, will sicken. It is necessary, therefore, to make a careful inspection of the excrement each morning for at least three weeks after the separation of the sick fowls. If yellow urates are discovered the birds must be watched until the sick one is detected. To facilitate the early discovery of such sick fowls and prevent infection of the healthy ones, it is advisable, where practicable, to sepa-

rate the birds into lots of two or three each at the start; and this separation may always be practiced as a last resort where the disease successfully defies our efforts for a considerable time; but where this is impossible a little patience will generally enable one to pick out the sick before any harm has resulted. As soon as the sick bird is removed the excrement must be scraped up and burned, and the run must be again sprinkled with the disinfectant; or the well birds may be changed to fresh ground as before. The method of management is to be continued as long as new cases of the disease occur.

5. Disinfection.—For this disease we have a very cheap and most effective disinfectant. It is a solution made by adding three pounds of sulphuric acid to forty gallons of water (or $\frac{1}{2}$ lb. of acid to 3 $\frac{1}{2}$ gallons of water) and mixing evenly by agitation or stirring. This may be applied to small surfaces with a common watering-pot, or to larger grounds with a barrel mounted on wheels and arranged like a street-sprinkler. In disinfecting poultry houses the manure must be first thoroughly scraped up and removed beyond the reach of the fowls; a slight sprinkling is not sufficient, but the floors, roosts, and grounds must be thoroughly saturated with the solution, so that no particle of dust, however small, escapes being wet. It is impossible to thoroughly disinfect if the manure is not removed from the roosting places.

Sulphuric acid is very cheap, costing at retail not more than twenty-five cents a pound and at wholesale but five or six cents. The barrel of disinfecting solution can therefore be made for less than a dollar, and should be thoroughly applied. It must be remembered, too, that sulphuric acid is a dangerous drug to handle, as when undiluted it destroys clothing and cauterizes the flesh wherever it touches. The safest way is, therefore, to take a five-gallon keg nearly full of water to the druggist and have him place the strong acid in this; the contents of the keg may then be safely transported and added to the barrel of water.

6. Fumigation.—In those cases where the disease has been raging for a considerable time the feathers become saturated with the contagion, and it is necessary, before placing the fowls on the disinfected run, to put them in a close building and thoroughly fumigate them with sulphur. For this purpose a pan of burning coals is taken and flowers of sulphur thrown upon them as long as the air can be breathed without danger of suffocation. When the disease is recognized at the outset this is not necessary.

PREVENTIVE MEASURES FOR GROUNDS NOT YET INFECTED.

1. Newly acquired birds to be isolated.—When cholera is raging in a locality, all birds introduced from other flocks should be placed in an inclosure by themselves for at least three weeks, until it is certain that they are free from the disease. No fowls should be accepted from a place known to be infected for at least a year after the last known cases occur.

2. Precautions in regard to eggs.—All the eggs from a distance to be used for hatching must be thoroughly cleaned of all particles of excrement adhering to them, and the water with which they are washed, as well as cloths or brushes used, must be raised to the boiling point before being thrown upon grounds to which poultry has access. The virus is always destroyed by a boiling temperature, or even by 140° F. if maintained for fifteen minutes.

3. Fowls not to wander upon adjoining infected premises.—A stone wall is in towns frequently the boundary line of an infected place, and though fowls are upon each side of it the contagion may not cross for years. In such cases it is a matter of the greatest importance to prevent the healthy fowls from trespassing upon the infected grounds.

4. Fowls from neighboring infected premises to be rigidly excluded.—If it is important to keep healthy fowls from infected grounds, it is not less important to exclude fowls living in infected quarters from entering on runs that are still free from the disease. Even though insusceptible to cholera and consequently healthy, they are able to carry the virus on their feathers and feet, and may even distribute it with their own excrement; for although the virus is unable to propagate itself in the blood and tissues of insusceptible birds, there is reason to believe that it may still multiply in the contents of their digestive organs.

5. Other infected substances to be excluded from the runs.—Manure from infected places is often purchased and spread upon land to which healthy poultry has access, and thus becomes the means of spreading the disease. This should either be entirely excluded from the farm or the fowls should not be allowed to come near where it is placed. It cannot be safely disinfected. Feathers and dead birds are also at times carried a considerable distance by various agencies, and should be guarded against when possible.

By a careful observance of these rules the fowl cholera may be excluded indefinitely, and may be exterminated when it has made its appearance. The writer has had a very virulent form of the disease among experimental fowls for nearly eight months, and though his home flock is but a short distance from them, but a few of these have sickened, and the disease has been checked with the loss of a single bird in each instance. It is believed that the birds which thus contracted the disease were infected by flies, which would gorge themselves with virulent blood in the laboratory, where dissections were made, and then fall victims to the poultry which were running about outside. No cases have occurred in this manner since the cold weather has destroyed these insects.

MARES IN FOAL.

SOME animals carry their young for an abnormal period, either shorter or longer, and this habit becomes characteristic with them. The Dutch cows are said to be more regular and to keep closer to the average period of 280 days than other breeds. A mare served by a thoroughbred horse will go longer with foal than one served by a cold-blooded horse, and a mare goes longer with a mule colt than with a horse colt; but precisely what this difference amounts to is not yet sufficiently established. The average period of gestation in the mare is 340 days. Recorded periods in 284 cases mentioned by Fleming in his "Veterinary Obstetrics" gives 307 days for the shortest and 394 days for the longest period—a mean of 346 days. In 25 cases noted at the stud at Pin in France, the shortest time was 323 days and the longest 367 days, the mean being 343 days. Baumeister states that the periods of pure bred Persian mares were 338 days for mare foals and 343 for horse foals; in pure bred Arabs there were 337 and 339 days for female and male colts respectively; in Orloff mares the average period was 341 $\frac{1}{2}$ days, and in half-bred English mares it was 339 $\frac{1}{2}$ days. The majority of foals are born from the 340th to the 350th day; living foals are rarely born from the 360th to the 310th day, but frequently from the 350th to the 365th day; after the

latter period a live birth is rare. Two cases are known in which the foals were carried several days longer than twelve months, and in each case there was a dispute as to the accuracy of the record by the owners, who wished to escape payment of the service fee, they disbelieving the possibility of so long a period. The longest period of the mare's gestation known is given by Dieterichs as 419 days. In 34 cases recorded at an English thoroughbred stud, the following periods were noted in 1870:

1 for a period of	316 days.
1 do.	318 "
1 do.	320 to 330 "
1 do.	330 to 340 "
15 do.	340 to 348 "
1 do.	354 "
Average	335 $\frac{1}{2}$ "
17 colts averaged	336 $\frac{1}{2}$ "
17 fillies averaged	334 "

The shortest and the longest periods, viz., 316 to 318 days, and 318 to 354 days, were with fillies. These shorter periods were with mares nineteen years old, and the longer with mares nine years old. Nevertheless, the records do not show that the period is affected by age, for instance:

Three five year old mares went	340
Two six do.	350 $\frac{1}{2}$
Three seven do.	328 $\frac{1}{2}$
Two nine do.	340 $\frac{1}{2}$
Two ten do.	336
Six twelve do.	337
Four fourteen do.	336 $\frac{1}{2}$
Five fifteen do.	333
Two sixteen do.	340 $\frac{1}{2}$
One seventeen do.	324
One eighteen do.	330
Three nineteen do.	315

It has been generally the case that the periods of gestation are shortened by the more favorable physical conditions prevailing in high-bred studs, where the keeping and the vigor are of the highest character. The period of the ass is always somewhat longer than that of the mare.—*Toronto Globe.*

WEST INDIA FRUITS.

AN English writer in Jamaica gives in an English magazine the following information with regard to the fruits of that island. "Few of the native fruits," he says, "will bear cooking. The guava, however, is an exception; it can be boiled into an insipid imitation of stewed pears. The well known guava jelly is almost as familiar in England as in the West Indies; but though very good for children, it is too sweet for the well-regulated taste of a prudent adult. Of the other fruits, by far the best are those which we have all eaten from our childhood upward—pineapples, oranges, grapes, and bananas. The new kinds which the visitor tries at first are only such as are not worth the trouble of exporting. After a while everybody settles down to a regular routine of oranges and pineapples. The rest never appear at table, and wisely. The sour-sops and sweet-sops are faint, sickly things; the custard apples are pappy and nauseous; the naseberries are very much like brown sugar and water, and the grandillas are about as good as overripe gooseberries.

"Fresh coconuts, however, I frankly and cordially recognize. They are picked very young, before the shell has had time to set, and are cut open by slicing off the top with a stout knife. The water—for it has not yet begun to get milky—is then poured out into a soda-water tumbler, and drunk at once, with a grateful lump of American ice bobbing up and down against the side. Nothing can be more delicious, with the thermometer at 90° in the shade; and I much prefer it myself for a constant drink to the weak rum-and-water which, under the suggestive name of mince-sheet, forms the staple beverage of most planters' households, being mixed in a big porous jar before breakfast, and emptied before night by half a dozen thirsty and bibulous souls. As to the meat of the coconut, it is represented at this early stage by a film of soft jelly lining the shell, which is scooped out and eaten with a spoon. In this form it is not indigestible, and its flavor is more delicate than in the ripe state. Indeed, nobody in the tropics ever dreams of eating ripe coconuts; they are only gathered to be sent to England or crushed for their oil. The cashew nut is another excellent Jamaica product. It grows on a swollen stalk, and its husk is filled with an intensely acid juice, so pungent as to burn the skin when one touches it; but by careful manipulation with a pair of crackers the kernel is extracted and roasted, and so forms a decided addition to the limited stock of desert fruits. In taste it falls under the same general category with pistachio nuts, which is about as near as one can get in describing that indescribable thing, an unknown gustatory sensation. After all, if a man has never eaten a peach, volumes could not tell him exactly wherein it differs from an apricot or a nectarine.

"The common tropical fruits of commerce are all to be had pretty good, though not so good as in England, where we get them from the well-tilled Azores. In Jamaica, as in most very hot climates, they are allowed to run too wild. The mangoes do not come up to Bombay samples. The pineapples are fair; the oranges too pulpy and not juicy enough. But there is a capital little passion flower fruit, fresh and acid; and limes are certainly a thousand times better than our flabby European lemons. Nobody who has once tasted them ever cares for flavorless lemon juice again.

"Among the vegetables, the first place belongs to what the Jamaican negro knows as bread-kind. Under the term bread-kind are included all those roots and fruits which form his staff of life, as bread does with the European peasant. Yam is the commonest article of food with the people, but there are several alternatives, such as bread-fruit, koko, and plantain. I have often wondered why yam is not imported for sale in this country. It is a very big tuber, often as much as two feet long and five or six inches thick; and one buys only a short slice at a time. When boiled and then made up into little roast balls, browned on the outside, it resembles a very meaty potato, only that it is much whiter, starchier, and better flavored. Indeed, its appearance is a good deal like that of the inside of a roast chestnut, but softer and less close grained. It is not in the least sweet, as many people imagine; being eaten with meat, exactly like potatoes. If introduced into England, yams would make an agreeable variety at our tables; and they have the double advantage of being very cheap and always good alike. There is no such thing as a waxy or gummy yam; they are invariably snowy white in hue, and like flour itself in texture.

Sweet potatoes, on the other hand—which are not potatoes at all, but members of a totally distinct family—are much less to be recommended. Their grain is like that of a very bad 'early red kidney,' their faint sweetness is very sickly, and their flavor strikingly reminds one of a toasted parsnip. Bread fruit, too, in spite of its pretty and tempting name, is remarkably poor stuff to eat. It never appears at white people's tables, being used only by the poorer class of negroes. Though it is in fact fruit, it is not in the least sweet, and it tastes much like very bad bread. The mode of dressing it is by baking it in an oven; and when it is opened it displays a starchy interior, with nutritious properties, no doubt, but not to be relished by the pampered Anglo-Saxon palate. Even the negroes help it down with a flavoring of Newfoundland and salt fish, and consider it but third-rate food at that. Koko is an inferior kind of yam, which I blush to acknowledge I have never made the object of an experiment. Plantains are big and coarse bananas, not so sweet as those which find their way to Europe, and wholly wanting in flavor. Roasted with brown sugar they form a favorite substitute for pastry with creole children; which is the most damning fact against the taste and intelligence of the creoles with which I am acquainted. English infants would vastly prefer the inexpensive pleasure to be derived from simply sucking their own thumbs. Even those exemplary babes who positively pretend to enjoy rice pudding would resent the insult to their nascent aesthetic faculties which would be implied by an offer of roast plantain. Molasses and boiled turnip are the only conceivable mixture which could faintly adumbrate its inexpressible nastiness.

"When I was talking of soups I ought to have mentioned the ocheo. This is a sort of pod or capsule which makes a thick and rather glutinous purée, not unlike Chinese bird's-nest. The taste is an acquired one, but after a time it becomes nice enough. The gummy consistency reminds one of good thick turtle. More questionable is the akee, a beautiful scarlet fruit cooked as a vegetable, but far too rich for bilious constitutions. It may be symbolically pictured as something like a boiled sweet-bread steeped in olive oil. The other Jamaican vegetables are the same as our own, with the addition of the American egg-plant and the Eastern chow-chow. The avocado pear—more often corrupted into 'alligator'—is a kind of natural salad, already prepared, except the dressing. Though externally like a pear, it has a large stone inside, and tastes like boiled cucumber. It is eaten with salt and pepper, generally at breakfast; but it has the ordinary lusciousness of tropical fruits, and is richer than I personally care for. Most people, however, are very fond of it."

WAR UPON INSECT PESTS.

THE California Horticultural Society adopted, at a recent meeting, the following rules for protecting fruit trees and vines from insect ravages:

1. It shall be required of every fruit grower, owner of an orchard or orchards or lands containing fruit trees, or persons in possession of land on which there are fruit trees which are infected with codling moth, its larvæ or pupæ (chrysalis), to destroy them on or before the 20th day of February of each year, by scraping off all rough bark and cleaning all cracks and crevices in bark and crutches. The scrapings must be carefully gathered and destroyed, by burning or otherwise. A sprud made of old grain sacks or other cloth material should be spread on the ground around the body of the tree before scraping. The trees thus scraped, washed with an alkali wash made from a soft soap containing at least five per cent. of potash, forty-five per cent. oil or fat, forty-six per cent. water, mixed with twenty-five per cent. of its weight of flour of sulphur, then mixed one pound to one gallon water. Instead of this wash may be used the whale-oil soap and sulphur wash known as codling moth wash.

2. All vegetation and other growth must be cleaned off the ground around trees infected with codling moth, its larvæ or pupæ, before the 12th day of May in each year, and the soil made as smooth as possible, provided that all premises under water may be excepted as to date.

3. All boxes or packages stored in orchards or adjoining store-rooms, sheds, or premises from one season to another, especially those used in the shipment of apples, pears, and quinces from orchards known to be infected with the codling moth, etc., or boxes and packages known to have been in contact with such, must be disinfected by dipping in boiling water at a temperature of not less than 212° Fahrenheit for at least two minutes, said water to contain not less than one pound of commercial potash, or five-eighths of a pound of concentrated lye to each twenty-five gallons of water.

4. All salesrooms, storerooms, packing-houses, or places where fruit, fruit-boxes or packages used in shipping pears, apples, quinces, or other kinds of fruit infected with codling moth, its larvæ or pupæ, or scale bugs (insects), or any noxious insects injurious to fruit and fruit trees, have been used or stored for any purpose, must be thoroughly disinfected as may be prescribed by the chief horticultural officer, or local inspectors or County Board of Horticultural Commissioners.

5. All fruit of trees infected by codling moth, scale bugs (insects), or any noxious insects injurious to fruit or fruit trees, must be picked off and destroyed by cooking and feeding to hogs, or in any other manner satisfactory to the County Board of Horticultural Commissioners or local resident inspector.

6. Before the 15th day of May in each year, one or more bands of cloth or paper must be placed on each tree of apple, pear, or quince in any orchard where such trees are known to be infected with codling moth, its larvæ or pupæ (grain sacks torn or cut in strips about eight inches are good), the bands to be fastened around the body of the tree by cords or wire, or in any manner satisfactory to the Horticultural Commissioner or local inspector of the district where such orchard is located.

7. The bands must be examined at least every sixth day, and the larvæ or pupæ found therein destroyed.

8. All fruit trees, plants, or cions (excepting grape vines and cuttings) infected by scale bugs (insects) must be thoroughly washed with an alkali wash as prescribed in Rule 1, or by such wash as may be prescribed by or satisfactory to the County Board of Horticultural Commissioners or local inspector of the district or county where such trees are located.

9. Any tree or trees in any orchard or in any place infected by red spider (mites) must be thoroughly washed with alkaline wash as prescribed in Rule 1, or such other wash as may be prescribed by the County Board of Horticultural Commissioners or local inspector of the district where such trees are located.

10. Empty boxes or packages returned from market, or any place, when shipped with fruit infected with codling moth, or the larvæ or pupæ of scale bugs (insects), or any noxious

insects known to be injurious to fruit or fruit trees, or known to have been in contact with any boxes containing fruit infected by said insects, must be disinfected by dipping in boiling water, as prescribed in Rule 3.

11. In cases where notice is served to disinfect empty fruit boxes, or packages used in shipping fruit the previous year, the time of notice shall not be less than three days. The time from service of notice given on boxes just returned from market or other places, whenever shipped with fruit, shall not be less than one day. The time from service of notice to destroy fruit on trees infected by codling moth or the larva thereof, scale insects, red spider (mites), or any noxious insects known to be injurious to fruit and fruit trees, shall be not less than six days. The time given from service of notice to place bands on trees shall not be less than ten days.

12. Any tree or trees, plants, or shrubs (grapevines excepted), infested by any species of scale bugs (insects), red spider (mites), or any noxious insect or insects liable to spread contagion to fruit or fruit trees, must be disinfected by washing with an alkaline wash as prescribed in Rule 1, or a wash prescribed as satisfactory to the County Horticultural Commissioners or local inspector of district where such trees are located.

THE TREELESS PRAIRIES OF THE WEST.

By Prof. THOMAS MEEHAN.

At a late meeting of the Academy of Natural Sciences, of Philadelphia, Mr. Thomas Meehan remarked that the absence of timber or arborescent growth on the grassy prairies of America still continued to be a matter of controversy, but he believed that in the light of accumulating evidence we might now come to a positive decision in regard to the question. The most prevalent belief had been that trees would not grow on these prairies—and we have had theories relating to soil or climate to show why they could not grow. Then there were others who believed that trees did grow there in ancient times, but had been burnt off, and kept burnt off by annual fires.

Mr. Meehan considered in detail the authors who had propounded various theories, and the distinguished men who had advocated them, and said that it was evident climate could have nothing to do with the question, because in these prairie regions there were often large belts of timber lands projected like huge arms into the grassy regions, with precisely the same climatal conditions over both. That the soil was not unfavorable was proved now by the artificial plantations everywhere successful, and that the soil was unfavorable to the germination of tree seed, as suggested by Prof. Whitney, was on the face of it untenable, from the fact that it required but the same conditions for the seeds of trees as for those of herbaceous plants, the number of species of which on the prairies was well known to be very large. Another great gain to our present knowledge was that since the annual firing of the grassy prairies had been discontinued by the advance of civilization, the timber was everywhere encroaching on them. Among the facts which he offered in proof of this was a reference to page 503 of the Seventh Report of the Geological Survey of Indiana, where Dr. Schneck shows how land which was once grassy prairie is now covered with a luxuriant growth of forest trees; to the evidence of Major Hotchkiss, Geologist of Staunton, Virginia, that the Shenandoah Valley, now heavily timbered, was clear of trees in the early history of Virginia; to the discovery of buffalo bones, in caves near Stroudsburg, Pa., by Dr. Joseph Leidy—now a timbered region, the buffalo only existing in open, grassy countries; and to various traditions of settlers in some valleys now timbered, that the land was originally clear of trees. He pointed out that in all known parts of the United States at the present time, except the arid regions, where only drought-loving plants could exist, the natural result of freedom was the succession of forest growth. Seeds were scattered by winds or animals over acres of cleared land; if such land became neglected, these, again seeding in time, extended the forest area continually. The tallest growing vegetation, like trees, crowded out the weaker, and the forest naturally crowded out the lower growing and weaker herbaceous plants. He illustrated this by reference to the neglected cotton fields of the Southern States.

From all this, the speaker said that it was evident that there was nothing in Nature, either now or in the past, to prevent the gradual encroachment of the forest over the grassy plains, till, long before the white man came here, the whole would have been completely covered by arborescent growth. Were there any artificial causes equal to the exclusion of trees, and yet permitting an herbaceous growth? If we were to sow a piece of land in the autumn with some tree seed, and some seeds of annuals, the latter would be up, flower, mature and scatter their seed to the ground before next autumn, and many of these seeds would be washed into the earth or drawn into the earth by insects or small animals. But tree seed would make young trees which would not again produce seed for ten or more years.

If now, at the end of this first season, a fire swept over the tract, the seeds of the annuals which had found a slight earthy protection, would come up again the next summer, again seeding and extending the area. The trees would be burned down, and though perhaps many would sprout, successive burnings would keep them confined to one place. In short, under annual burnings, herbaceous plants could still increase their area annually, but trees could never get far beyond the line they had reached when the annual fire first commenced.

There could be no doubt that an annual burning in a tract destitute of forest growth would certainly prevent the spread of timber, or of any plant that required more than a year to mature seed from the time of sowing. Now, if we look at the actual facts, we find that the Indians did annually fire the prairies.

Father Hennepin, the earliest writer on Indian habits, noted that it was the practice in his time. There is little doubt but this practice of annual burning has been one extending long into the past. What object had they in these annual burnings? They must have known that the buffalo and other animals on which they were largely dependent for a living, thrived only on huge grassy plains, and that it was to their interest to preserve these plains by every means in their power. Low as their power of reasoning may be, they could not but have perceived that while grassy herbage thrived in spite of fires, perhaps improved under the fiery ordeal, trees could not follow on burned land. What could be more natural than that they would burn the prairies with the object of retaining food for their wild animals? If we have no difficulty in reaching a positive conclusion so far, we may

now take a glance at the early geological times. Mr. Meehan then referred to the researches of Worthen, Whittlesley, and others, in Ohio, Illinois, and other prairie regions. On the retreat of the great glacier, the higher lands and drift formation were probably high and dry long before the immense lakes formed from the melting and turbid waters ceased to be.

It was tolerably well understood that many species of trees and other plants which required a temperate atmosphere retreated southwardly with the advance of the glacier, and advanced to higher latitudes on the glacier's retreat. Thus these higher ridges would become timbered long before the lower lands became dry.

Evidence accumulates that man existed on this continent, in the far west, not long after the glacier retreated, though "not long," in a geological sense, may mean many hundreds of years. The lakes of glacial water would gradually become shallower from the deposit of the highly comminuted material brought down from higher land, from the wearing away of rocky breastworks as in South Pass, Illinois, as well as from the opening which would continually occur from nature's ever varying plan of streams underground. In all events, the drying of these lakes would be from their outward edges first. Aquatics would give way to marsh grasses, and these to vegetation such as we now find generally spread over the prairie region.

If now we can conceive of human beings such as we know the Indian races to be, already in more southern latitudes—having learned the fact that firing would keep down trees and aid in the preservation of the chase—following the retreat of the glacier to the higher lands, and still as they advanced northwardly, firing the plains up to the water's edge, it would certainly account for the absence of arboreal vegetation from these immense lacustrine lands from the very beginning of their formation.

Of course with this view we should have to look for some evidences of man's existence, both on the lands which were once under water, as well as those which were timber lands at his first appearance there. He did not know how many such evidences have been or may be found. Man's traces in the past are at best but rare, and they would naturally be much more scarce in lacustrine regions than in lands dry at the same epoch. At any rate, this part of his remarks, he said, must be taken as mere speculation; but, as we could see on the basis of sound scientific investigation why there could be no trees on these grassy prairies within the range of indubitable history, it was a fair inference that some such cause had continued from the beginning; namely, that annual fires had ever been the reason why arborescent vegetation had never had an existence there.

THE EUCALYPTUS GLOBULUS.

Report by Consul JOHN WILSON, of Brussels.

I HAVE the honor to transmit herewith the description of a tree known in botany as the *Eucalyptus globulus*, indigenous to Australia, but now extensively cultivated throughout Southern France with most satisfactory results. I have translated the entire article descriptive of this tree as it was originally published in France, and has again recently appeared in an agricultural journal of this country, thinking that if but half the good qualities claimed for it be true it must be admirably adapted to the treeless regions of Southern Kansas, Texas, and, indeed, all our Southern Territory. It is not improbable that the existence and qualities of this tree are already well known to our Department of Agriculture, but as I have no means of ascertaining this fact, and as the great question of planting our treeless prairies and renewing our fast disappearing forests is now claiming so much of the attention of the government, I have thought this article worthy of notice, and therefore submit the translated copy for your consideration. I may add that if no experiments with this tree have yet been made in the United States, and it is thought worthy of a trial, I can procure from the famous gardens of the horticulturist and arborist, Van Houte, of Ghent, any quantity of the seed for distribution.

EUCALYPTUS GLOBULUS.

Nothing is more curious than this Australian tree, yesterday nearly unknown in France, and to-day on the point of producing a revolution in the sylviculture in the south, and perhaps in certain industries also. It develops with a prodigious rapidity, its wood is very hard and resinous, and is neither affected by water nor attacked by insects.

The eucalyptus flourishes in the south of France, especially in the Maritime Alps, where, thanks to the efforts of Dr. Gimbert, its culture is constantly on the increase. At Cannes its mean yearly growth is about four meters. Seedlings a year old, planted in the month of May in favorable ground, reach the height of six meters by the following December. Throughout all of Southern France, if planted in good ground, the eucalyptus in seven or eight years attains a height of from 20 to 25 meters. It is an elegantly proportioned evergreen, and sheds a very agreeable balsamic fragrance.

It is, therefore, of the highest importance to draw the attention of sylviculturists and economists to this remarkable tree, for the replantation of the forests in Southern France and Algeria. This is a source of wealth worthy of the most serious considerations.

The ordinary timber-trees in France are cut from the forest, on an average, every hundred years; the eucalyptus can be cut five times in that period, or once in every twenty years.

It will be seen by this that the value of timber forests would be quintupled by the culture of this tree.

It has been calculated that a cross-tie for railroads, which now costs 8 francs in France, would only cost from 1 to 2 francs if made of eucalyptus wood.

An ordinary pine tree fit to furnish a telegraph post of 6-50 meters high requires a growth of thirty years, and costs 6-50 francs, while the eucalyptus will grow the same post in five years; and from this it may be seen what an economy must result from the growing of this tree for these purposes.

It is well known that, in consequence of the rapid extension of our naval constructions, we are obliged to import much timber from Russia, Sweden, Norway, and the United States. The culture of the eucalyptus would in time completely relieve us from having recourse to these foreign sources of naval timber. All the masts, hulls, and indeed the entire framework of ships can be made from this tree. All the wooden vessels that now ply between Australia and England are chiefly made of it. The whaling vessels of Hobart Town are made of this wood, and throughout Australia it is extensively employed by carpenters, wagon-makers, wheelwrights, etc. A hectare of land, planted with the eucalyptus in lines 6 meters apart with 3 meters between

the trees, will contain 500 trees. If they are well planted they will all have a diameter of 20 centimeters in three years, and a tree of this dimension is very useful to mechanics and wheelwrights, and can be sold for over 5 francs each. Thus the first cutting would produce 2,500 francs per hectare. At eight years, the trees of such a plantation would have acquired the dimensions suitable for railroad purposes, and each tree would be worth 20 francs. A hectare of this plantation would then be worth, according to Mr. Frothier, 6,200 francs.

Large plantations of this tree could be made rapidly to invade and cover swampy grounds, more or less previously drained, and so change its character as to entirely prevent the emanation therefrom of noxious miasms. Such plantations would prevent the direct action of the sun's rays upon the ground; would extract any excess of humidity from it, and would thus absorb all the elements of a parasitic and unhealthy vegetation. Thus, on a ground formerly uncultivated and pestilential, at the end of ten or twelve years from the planting, a strong, generous, and health-giving forest might be produced.

Intermittent fevers do not exist where the eucalyptus grows, and travelers think that Australia owes much of the salubrity of her climate to the fact that so much of her territory is covered with this tree.

Mr. Gimbert, strongly recommends the plantation of the eucalyptus in certain regions of Spain, the treeless plains around Rome, the vicinity of Piestum, the deltas of the Var, the coast of Corsica, etc., which are during the hot season humid, and hence the seat of intermittent fevers.

The eucalyptus contains an essence which is easily extracted, and of which Dr. Gimbert has shown the happy medicinal properties. This essence has, among others, the property of a febrifuge, anti-spasmodic, and anti-asthmatic. Mr. Gimbert, who, at Cannes, was the physician of Prosper Mérimée, tells us that the illustrious writer for three years used cigarettes of eucalyptus, and that they always calmed his asthmatic oppressions.

These facts speak for themselves, without it being necessary for us to add anything farther. The eucalyptus is a precious conquest, of which we must now try to profit.

FLOWERS AND INSECTS.

M. GASTON BONNIER, well known from his researches on plants, delivered at the Sorbonne, recently, a lecture on flowers and insects, replete with new and curious observation, and which is reproduced in full in the *Revue Scientifique*. M. Bonnier is not a believer in evolution, although he admits that he was at first much taken with the theory, and it was with a view of verifying some of the points advanced by Darwinists that led him to devote much attention to the mutual relations existing between flowers and insects.

To bees, says Sir John Lubbock, one of the disciples of Darwin, we owe the color of our flowers and the perfume of our fields. Not only have the form and present contour, the brilliant colors, the sweet odor, and the honey of flowers been gradually developed by the unconscious selection exercised by insects, but the very arrangement of the color, the circular bands, the radiating lines, the relative size and position of the floral organs, are arranged with regard to the visits of insects in such a way as to insure the great object that these visits are designed to effect. To sum this theory up in a few words, it may be said, with evolutionists, that insects and flowers have been mutually created for each other.

Passing over the detailed explanation given by M. Bonnier of the role of the pollen and nectar which are gathered by bees, we come to the arguments that the author puts forth to refute the doctrine in question. First, take for example the relations that are alleged to subsist between the humble-bee and the foxglove. The leaders of the Darwinian school have sought to explain in a very ingenious way the adaptation of this flower to the body and organs of the insect. Yet a minute examination of the facts will quickly show the hypothesis to be untenable; for, if it were true that the humble-bee and the foxglove were fashioned for each other, what explanation can be offered of the two or three holes which this insect pierces at the base of the corolla in order to get at the nectar more readily? The fact is, the bee finds that all that system of floral organs, which is said to have been especially arranged for him, much too complicated, and to avoid the trouble of parting the two lips and the stamens, and thrusting his tongue down to the bottom of the flower, he thinks it easier to make a hole through the base of the floral envelope without touching the stamens or pistils. So he steals the sugary liquid and does nothing toward aiding the flower to perfect its seeds. But this simple hole bored in the corolla has still graver consequences for the theory in question. The humble-bee has a very long tongue, and he alone could reach the bottom of the foxglove, but now that he has made an aperture at the base, honey-bees and a host of other insects with shorter tongues, and not adapted to the flower of the foxglove, come to seek the nectar through this same aperture. The corollas of very many other species of flowers would likewise show us holes bored either by humble-bees or other insects.

Again, if every flower has its insect, and every insect its flower, how does it come that the wild balm (*melissa*), notwithstanding its penetrating perfume and its attractive color, receives no insect visits? And why does the same thing happen with regard to the corn poppy, the lily, the hyacinth, the anemone, and many other flowers? Experience tells us that it is simply because these flowers offer no nectar to insects. It is a curious thing, too, and also opposed to the doctrine referred to, that vetches are visited by insects before the flowers open, for here the honey reservoir is not found in the corolla, but at the base of the leaves.

The honey-dew sometimes observed on the leaves of certain trees and shrubs, and which is so largely sought by bees, cannot be explained, either, by the theory of the adaptation of forms.

If we take a package of seeds of some flower, and sow half of them in Southern Europe and the other half in Scandinavia, it will be found that the flowers which bloom in the North have brighter colors than those that are grown in the South, where insects are in greater abundance. If flowers have brighter colors and a greater quantity of nectar in northern regions, it is to be attributed, says M. Bonnier, not to insects, but to the continuous and diffused light of the summer days of Scandinavia. Analogous phenomena are observed on the Carpathians and Alps, where the flowers are also more highly colored and more nectariferous, because the atmosphere in measure as we ascend absorbs less and less light.

Moreover, if these facts are not sufficiently convincing, try the experiment of placing in front of a beehive four pieces of cloth each of a different color, but smeared with the same quantity of honey. It will be found that the bees

* Since these remarks were made it has been brought to the attention of the author that the bones may have belonged to the wood buffalo.

will not visit the red or the black or the white piece in any greater numbers than the green one, although the latter corresponds with the color of the surrounding leaves and grass. Again, remove from a flower those very portions which, according to evolutionists, have a useful role to perform. It will be found that, so long as flowers thus treated preserve their nectaries intact, they will not cease to be visited by insects. But it may be asked, perhaps, if the flower has not been created for the insect, what purpose do the nectaries serve? What is the function of these reservoirs of sugar?

Although all flowers are not provided with nectaries, none is entirely deprived of them, whether the sugar exudes or not. This saccharine matter, like that contained in the root of the beet, goes to nourish the fruit. So, in proportion as the ovary goes on developing, the nectary gradually atrophies and disappears entirely. Under the influence of a soluble ferment, a sort of diastase, the crystallizable sugar of the plant becomes transformed into glucose, and is then in a state to be assimilated. The exudation of the nectar is due to a transpiration that can be produced artificially, by the action of heat and moisture, on plants which, under ordinary conditions, are not nectariferous.

M. Bonnier concludes, then, that adaptation between flowers and insects is contradicted by well-established and most convincing facts.

THE REASONING FACULTY OF ANIMALS.

By JOSEPH F. JAMES.

MUCH has been written on the subject of instinct and reason in animals, the question as to whether they possess reason is nearly as far from being answered as ever, and people continue to write and argue with the same pertinacity as of yore. Some writers have maintained that all the actions of animals lower than man, are performed by a something designated as instinct and that this was a faculty given by Divine power to animals, to take the place of reason possessed only by mankind. Others have said that both animals and men have reasoning powers, but the former in such a limited degree as to be hardly noticeable. Still others contended that animals were actuated to a very great extent in their actions by reasoning faculties, and that entirely too much stress has been placed upon the powers of instinct; while a last party have said that neither man nor beast is possessed of reason, but that both perform all their actions automatically, and, being under the influence of unchangeable law, do what they do because they cannot do otherwise.

In the old time, before we knew as much about the animal world as we do now, the unerring faculty of instinct was expatiated upon times without number. All animals were set down as without reasoning powers, and when one did perform an action out of accordance with its usual life, it was looked upon as a most remarkable phenomenon, and as instinct working in an abnormal direction. Besides, this instinct was thought to be bestowed by the Deity directly upon the animal. In later days this is not so much the case, and many consider that the sooner we discard the idea of instinct, and the sooner we attempt to explain the actions of animals upon the theory of their possessing reason, just that much sooner will we be able to come to a just conclusion.

It can hardly be denied that there are some actions which, instinctive in the ordinary sense, are transmitted from one generation to another, and are performed by all alike. Let us see if we can not find a reasonable ground for the first introduction of some of these instincts.

There was a time when the first mud wasp stung its first spider or grub, and deposited it in the first nest for the use of its young. But how do we know that this action was performed as successfully by the first female wasp, as it is now by her descendants? Would it not be just as reasonable to suppose that the present perfection of this action, if it be perfect, was the result of long experience, and of a gradual improvement from generation to generation, as to imagine that the first wasp succeeded as well as her descendants do now? There was a time when the first chicken was hatched and scratched the ground. But is it necessary to suppose that the first born of the jungle-fowl of India acted as our barnyard fowls do now, to account for the ability of the new-born chicks to run over and scratch the ground? Not so. These actions, and perhaps many more, are hereditary faculties, imperfect and crude at first, but gradually improving and perfecting, and transmitted from generation to generation in the same way as a taste for engineering, a liking for science, or ambition to be a soldier, descends from father to son. The gradual development of the mind of animals and of man, is under the influence of the same laws as the development of the body.

It is probable that the first pair of jungle-fowls of India, way back in antediluvian times, hatched a brood of young ones, which stayed in the nest till fully fledged, as do the young of most all birds. Suppose an accidental event occurred, which made it advantageous for the young chick to be able to run and scratch as soon as it broke out of the shell. Suppose it was found by nature, that the chick that could run away soonest after being born, would be the one most likely to escape from the clutches of the hawk when the mother was driven from the nest. The additional safeguard of life would be seized upon, and by gradually strengthening the ability to run, it would be transmitted in an improved form through the birds which escaped by running, to their descendants, and finally be bequeathed to their posterity in the form in which we now find it. Such an explanation would apply to quail and grouse, and, in fact, to all birds which run as soon as hatched, and seek to hide themselves from their enemies in the grass and bushes. This instinct in young chickens is by no means so perfect as it might be; for any one who has noticed them when just hatched, and led by the hen, will have seen that they stumble and stagger, sometimes going head over heels in their efforts to pick something up. So that even if it were instinct, it is perfected by practice.

Then again with the wasp. The one which provided best for its offspring would leave the most descendants; and the faculty and the ability to provide would be transmitted from generation to generation, being improved each time by the natural laws of modification with descent and by the struggle for existence. So with the cells of the bee. Mathematicians have been struck with astonishment, and held up their hands in holy wonder, to see such an insignificant insect as a bee making a cell more mathematically accurate than they

can after a lapse of 2,000 years! But it was a matter of necessity to use as little material and occupy as little space as possible with his cells. The ancient bees doubtless made their cells much less mathematically correct than the present ones are supposed to do. And it was only when the use of less wax, and of less space, gave one hive the advantage over another in the struggle for existence, that the present cell began to appear. It was not made so because of the instinct of the bee, but because the laws of nature compelled it to be made so, if the bee would hold its own in the struggle. We know well that bees do not make their cells always exactly alike, nor as exactly hexagonal as we are often told. They depart from the regular shape, and use other forms to suit circumstances, and we have here a clear evidence of the reasoning powers, and of the faculty of adapting means to ends.

Again we are told that many insects lay their eggs upon the leaves of certain plants, upon which the larvae feed, and upon no others, and it is pointed out as a case in which the Almighty has endowed the creature with an instinctive knowledge of the plant. But why should it be so? The white butterfly lays its eggs upon the cabbage, and the larvae feed upon its leaves. What right have we to say that the butterfly does not know the cabbage? There may be something about that plant agreeable to her olfactory nerves, which induces her to alight and deposit her eggs. Or it may be that in ancient days, and must have been, the butterfly deposited her eggs upon any plant indiscriminately. If those that fed upon the cabbage thrived better than those on some other plant, they would be preserved in the struggle for existence, and leaving more descendants than their rivals, would thus transmit the habit of frequenting more and more the cabbage plant. Perhaps at the time some species of insects originated, the ancestor of all deposited her eggs upon any plant most convenient. All may not have been suitable, but the larvae thrived on those that were, and frequented the same plant afterward; and thus in feeding on different plants and leading different lives, the one original species became differentiated into distinct but allied species.

The instinct which induces the cuckoo to lay her eggs in the nests of other birds can be shown to have arisen in much the same manner as those to which we have referred. Mr. Darwin gives an excellent account of how the instinct might be developed. He says: "Now, let us suppose that the ancient progenitor of the European cuckoo had the habits of the American cuckoo, and that she occasionally laid an egg in another bird's nest. If the old bird profited by this occasional habit, through being able to migrate earlier, or through any other cause; or if the young were made more vigorous by advantage being taken of the mistaken instinct of another species, than when reared by their own mother, encumbered as she could hardly fail to be by having eggs and young of different ages at the same time; then the old birds or the fostered young ones would gain an advantage. And analogy would lead us to believe that the young thus reared would be apt to follow by inheritance the occasional and aberrant habits of their mother, and in their turn would be apt to lay their eggs in other birds' nests, and thus be more successful in rearing their young." This explanation seems to us simple and at the same time adequate, and the same process of reasoning applied to all instincts of like character would, with little modification, be sufficient. Such instincts as the last, the hive bee cells, the case of butterflies laying eggs on plants, the slave-making habits of ants, and many more which will recur to any one, are brought into existence accidentally, and given a tendency to variation in any faculty of the mind or power of the body, and we can expect to see it modified by nature's seizing upon the favorable variations, transmitting them in an improved state each time, by inheritance from one generation to another, until they reach such perfection that men are astonished, and can see no other way of accounting for the fact, but by bringing to their aid divine power and intervention.

Now we are told that instinct is some power or principle possessed by animals, by means of which they perform, blindly and ignorantly, works of an intelligent nature; further, an impulse by which they are directed, without previous instruction or experience, to do unerringly what is necessary for the preservation of the individual or the species. The fact that instincts are not unerring goes far to prove that they had some such origin as we have described. It is known, for instance, that butterflies and moths often lay their eggs upon plants or in positions where their larvae can not flourish. What is this but a return to a former method of proceeding, when the insect laid her eggs on any plant? Here the instinct fails utterly, and not only does not assist in the preservation of the species, but is instrumental in destroying it. Cattle are supposed to know by instinct poisonous from beneficial plants, but take them to a new country, and they at first are as likely to eat the poisonous ones as those that are not. Their so-called instinct fails, because it is not an instinct at all, but the result of experience and observation. The instinctive dread birds have of man is often spoken of; but that is no instinct either. Birds and animals of all kinds in a state of nature, where they have never been molested or disturbed but little, have no great dread of man, and it is only after they have learned by dire experience and by observation the evils likely to fall upon them from the advent of man, that they show any dread or fear of him. This dread is then transmitted to their offspring, but is by no means an inherent faculty of the birds or animals' mind.

It is said again that a marked instinct is shown in birds by their nest building. Some say the bird makes as good a nest the first time she tries, as when she becomes old and experienced. But this has been emphatically denied, and is doubtless untrue. An observer has given an account of the first and subsequent attempts of one pair of birds to build a

nest; and he shows conclusively that the first was a poor specimen of bird architecture, the second was an improvement, the third still better, and so on until the art was finally reached of making a handsome and serviceable nest. Alexander Wilson, one of the best of ornithologists, believed implicitly that birds improve in nest building, and gives several instances of it. Birds learn to sing, too, by a long apprenticeship. At first the song consists merely of a few disconnected notes. By continual practice the art is developed, and at last the bird carols forth the lay which delights all hearers. It is not the result of instinct, but of practice and gradual improvement. Mr. Wallace believes that as man performs many of his intelligent acts merely by imitation, so it is with birds in making a nest.

One would think that if there is any action which is instinctive with water animals, it would be that of swimming, yet this is not always the case. A writer in *Harper's Weekly* stated that "were a young seal taken, three or four weeks after birth, and thrown into deep water, it would drown miserably in a few minutes; they begin to grow accustomed to the water at the end of three or four months by degrees, and it takes a pup about three weeks' practice at the surf margin before it can handle its flippers properly in the water." Here instinct is out of the question, for to be that, the ability to swim would be manifested almost at birth.

We have granted that some animals are possessed of instincts, but we deny that these are implanted by divine agency, and contend that they come into existence in obedience to natural laws. We contend also that outside of these instincts proper, animals of all classes, from insects up to monkeys, perform acts which are certainly analogous to those performed by the human mind, and which ought to rank with the reason of man. Reason, we are told, is the power by means of which one proposition is deduced from another, and of forming a conclusion from known premises. Now if it could be proved that animals are possessed of feelings of love, hate, jealousy, grief, kindness, memory, and many other human traits; that they can distinguish right from wrong; if it could be proved that they are capable of drawing conclusions from known premises; and that they can and do follow out a train of reasoning; then it would be proved beyond all peradventure that they do have reason, and to a very marked degree.

There are thousands of anecdotes relating to all classes of the animal kingdom, showing in a greater or less degree the reasoning faculty. It is obviously impossible to give anything like all of them here, and a few of the more striking and relating to the principal classes will serve to point out our moral and adorn our tale.

Of the Articulates, the Crustacea are considered low in the scale, yet instances showing reason are recorded of them. Darwin tells us of a shore crab seen in Brazil by Mr. Gardiner. The animal was making its burrow in the sand, and Mr. G. threw some shells toward it. One of them rolled in, and three others lodged on the edge. The crab in about five minutes brought out the shell, and carried it off about a foot and dropped it. Returning and seeing the three other shells near the edge of his burrow, and apparently thinking that they too might roll in, he carried them off one by one, and deposited them with the other. Did not this animal reason on the subject in the same manner as a man would? Most decidedly so. Hermit crabs have been seen to rob one another of their shells. A big one was once seen to give chase to a little crab with a shell much larger than his own. "The little one, apparently quite alive to the sinister intentions of his pursuer, took to flight as quickly as possible; and his attempts to escape were continued with the utmost vigor until further effort was hopeless. At length he was overtaken, and then a regular pitched battle ensued. The little one resisted manfully, but was finally overcome, the more bulky opponent having, after the most strenuous exertions, succeeded in forcing his claws between the body of his weaker opponent and his shell, and with the most frantic exertion turning him out. They then, apparently as a matter of course, exchanged shells, the ousted tenant yielding submissively to his fate, and quietly adapting himself to his reduced circumstances." Suppose a man with boots too small for him, saw a little man with boots much larger than his own. Suppose society in such a state as to allow the big man to rob the little one of his boots, and leave his own for the use of the other. Would the man act by reason or by instinct? The answer is obvious.

Insects are higher than crabs in the animal creation, and among them we find the best developed instincts with a high degree of reasoning. Take for instance the ants. They live in communities, and some obey, while others command; some work, while others direct, so they must have a method of communicating ideas; they recognize their comrades after being separated from them for months, and therefore have memory; and language and memory are two of the highest gifts of man's mental nature. Bees can distinguish one kind of flower from another; they bite holes in the base of the corolla to get at the honey when it is too far for them to reach from the top, and when the hole is once bitten will always seek it; thus one individual takes advantage of the labor of another. They can alter the shape of the cells of their hive to suit circumstances. They are compelled to learn how to distinguish the situation of their hive when moved to a new place by circling round and round in the air and taking mental notes of its position, and it is only after observation, experience, and practice that they can fly directly to the entrance. Wasps learn the position of their nests in the same manner. They are capable of being tamed and of recognizing their masters, as are also butterflies.

¹ American Ornithology (16mo, Edinburgh edition, 4 vols., 1831), i., 179, 180, 190. See also article by Dr. Brewer, "On Variation of the Nests of the same Species of Birds," *Am. Nat.*, xii., 38. Wallace, "Contributions to Natural Selection," p. 257. Article from *Revue des Deux Mondes*, in *Pop. Sci. Monthly*, ii., 435, and others.

² Darwin's "Descent of Man," 1st ed., i., 33 and 54. Wallace, *ibid.*, p. 220 et seq.

³ Wallace, *ibid.*, "Essay on Philosophy of Birds' Nests."

⁴ Lindsey, in his "Mind in the Lower Animals," says that even in the Protozoa we find manifestations of purpose. "That, in fact, all the orders of the Invertebrata are possessed of intelligence, foresight, and reason to a greater or less extent. This is especially the case with ants." i., pp. 52-53.

⁵ "Descent of Man," 1st ed., i., 335.

⁶ Wood's "Man and Beast," N. Y., 8vo. ed., p. 85.

⁷ Sir J. Lubbock in *Am. Nat.*, x., 156 et seq. Also note in *Pop. Sci. Mon.*, ix., p. 253. Article on "Habits of Ants," in *Pop. Science*, xi., 39.

⁸ Huber, "Recherches sur les Fourmes," quoted in Kirby and Spence, i., c., ii., 66. Lubbock, *ibid.*, x., 154.

⁹ Darwin, "Cross and Self Fertilization in Vegetable Kingdom," p. 418.

¹⁰ Huber, *Linn. Trans.*, vi., 222, quoted by Kirby and Spence, i., c., ii., 516. Darwin, *ibid.*, pp. 436 et seq.

¹¹ Kirby and Spence, i., c., ii., 475-489.

¹² Huber, *Recherches*, p. 100, quoted by Kirby and Spence, i., c., ii., p. 520.

¹³ Sir John Lubbock's tame wasp has become historical.

¹ The latest book taking this ground is "Mind in the Lower Animals," by W. Leister Lindsay, 2 vols., 1880.

² Descartes' idea of animated machines. It has for its strongest supporter Professor Huxley. See article "Are Animals Automata?" by T. R. Huxley, in *Popular Science Monthly*, v., 734.

In districts where some species of dung beetles are found, they have the habit of depositing eggs in pellets made of horse or cow manure; but in districts where sheep are kept, instead of making the pellets, the insects use the pellet shaped excrement of these animals.¹ Beetles assist one another in their work and communicate ideas.²

If it seems unreasonable to say that an insect, without any distinct brain and nothing but a system of ganglia, can reason in such a manner, we might ask, What do you know about the mental powers of insects? How can we gauge their sight and compare it with ours, when their eyes have often hundreds of facets?³ Or know aught of their feelings when we know that some feel with their antennae?⁴ Or anything about their hearing, when some hear with their antennae, some with their fore legs, and some with their wings?⁵ We don't know anything about it, and perhaps never will.

Many stories are told of the actions of toads. They can be easily tamed, will feed out of one's hand, and come at a call. Here is an anecdote of one. A lady was sitting in a garden, when she saw a large toad moving along the base of a wall, and examining it most systematically. He raised himself on his hind legs, peered into a crevice first with one eye and then with the other, and pushed his paw into the aperture. Apparently dissatisfied, he continued his operations and examined another, and then a third. This last seemed to satisfy him, and slowly drawing himself up, he disappeared into the crevice. He evidently knew his own size, and selected a hole big enough to crawl into without effort.⁶ All fishermen know how difficult it is to induce an old trout to take the fly, and when hooked how successful he often is in tangling the line, or snapping it off against roots or stones. He has gained by long experience a knowledge of the traps set for him by man, and uses his knowledge in keeping out of the snares, and breaking away when caught. He has sense enough to know the danger he is in, and reason enough to keep out of it.

In respect to the reasoning powers of birds, there are so many anecdotes that it is difficult to make a selection. Every one knows how easily many birds are tamed; the crow or raven for instance, and above all the parrot, and how cunning they are in hiding any article they wish to keep to themselves. Swallows know that the hawk is their enemy, and sometimes take great delight in pestering him. Dashing forward as if immediately into his claws, then suddenly swerving off and enjoying the discomfiture of their enemy, who thought to have a feast. A swallow had become entangled by the leg with a string. His cries attracted some companions, and after a consultation they conceived a method of releasing the captive. They commenced to fly past the bird one after the other, each pecking at a certain point on the string as he passed, until it was cut in two, and the bird freed from bondage. A story is told of a goose and a hen. The latter hatched out some duck eggs, and of course the ducklings wished to take immediately to the water. The hen objected seriously, but without avail, and while she was mourning over the obstinacy of her brood, a solitary goose swam up, and with a noisy gabble took charge of them. After piloting them up and down for a while, they were turned over to their foster mother. Next day the same scene was repeated. This time the goose came close up to the bank, and without further parley the hen jumped on her back and sailed about while the ducklings were enjoying their swim. This took place day after day, until the ducks were large enough to take care of themselves.⁷ A gentleman busily at work in his garden had his attention attracted by a robin, who was acting in a curious manner. Feeling some curiosity to know what was the cause, he followed the bird and was led directly to her nest. There he saw a black snake which was in the act of robbing the nest. After the snake was killed, the bird showed great joy; flew down and pecked at the dead animal with every appearance of hatred, and then lighted on the gentleman's arm and poured forth her delight and gratitude in song.

With respect to mammals, it is hardly possible to see how any body can deny that they often reason. Who can not think of instances of the intelligence of dogs? or of a horse? or of the elephant? A very few anecdotes must here suffice. A retriever was observed by a workman busily collecting grass and leaves and carrying them in his mouth to one place. On examining the spot he found a hedgehog closely rolled up. When the dog had collected a sufficient quantity of grass to prevent the spines wounding him, he took the bunch in his mouth and trotted off. Darwin tells a story of another retriever which most conclusively shows reason. "Mr. Colquhoun winged two wild ducks, which fell on the opposite side of a stream. His retriever tried to bring over both at once, but could not succeed; she then, though never before known to ruffle a feather, deliberately killed one, brought over the other, and returned for the dead bird." He also quotes Rengger in regard to American monkeys. Rengger states that, when he first gave eggs to his monkeys, they smashed them, thus losing much of their contents; afterward they gently bit one end against some hard body and picked off the bits of shell with their fingers. After cutting themselves only once with any sharp tool, they would not touch it again, or would handle it with the greatest care. Lumps of sugar were often given them wrapped up in paper, and Rengger sometimes put a live wasp in the paper, so that in hastily unfolding it they got stung; after this had once happened, they always first held the packet to their ears to detect any movement within.⁸ A baboon in London had the habit of adopting animals. Once a young kitten scratched him. He was astonished, and looking at the kitten's paws, immediately bit off the claws. Animals, monkeys especially, use sticks and stones as instruments and weapons. A party of baboons in Africa were attacked by men at the entrance of a narrow pass in the mountains. The animals were up on the mountain side, and rolled the stones down into the pass so thick and fast that for a time it was completely blocked. The orang in Borneo knows how to handle and throw sticks in the same manner, and even makes himself a bed in the tree to sleep at night, covering his head with leaves.⁹ Humboldt refers to the horses and mules used in crossing the Andes. "Thus the mountaineers are

heard to say, "I will not give you the mule whose step is the easiest, but the one which has the most intelligence."

It is hardly possible in the limits of an article like this to do justice to our subject, but we are sure that what little has been said will show to a fair and impartial reader that animals certainly do possess a large amount of reason. There may be those who prefer to think that instincts are given to animals in a perfect form by the Almighty. These seem to think that, in taking the matter out of the Creator's hands directly, and placing all animal life under the control of natural laws, we thereby detract from His power. But not so. For He made laws by means of which animal life has progressed on the globe, and after the establishment of these laws, He holds Himself aloof from interfering. It is more degrading to the grandeur of the Infinite to suppose He has been compelled to interfere constantly with the works of His hands, than to suppose that He has, in the first place, established laws immutable and unchangeable, and endowed the first germs of life with the possibilities which have led to such grand results as are visible in the animal kingdom. —*American Naturalist*.

THE MOUND-BUILDERS.

PRESIDENT PRATT, of the Davenport Academy of Natural Sciences, says: The mound-builders were very numerous throughout the Mississippi valley. They dwelt mostly, if not exclusively, in the neighborhood of the rivers. They were people entirely distinct from the North American Indians, as we know them, had occupied the country in much earlier times than the latter, and were entirely unknown to them, even by tradition.

Like the modern Indians they were of different tribes, but less warlike and less nomadic, more domestic in their habits; yet their dwellings must have been of the most imperfect and perishable character, no traces of them being found.

They practiced cremation, though but to a limited extent, and only upon great and unusual occasions.

They lived in a very simple manner, possessed few mechanical contrivances, but were a laborious, pains taking people. That they had some system of barter with neighboring tribes at least (though perhaps limited to mere occasional exchanges as opportunity offered) is shown by the occurrence in the mounds of large sea shells, which, at the nearest, must have come from the Gulf of Mexico; obsidian, which must be from the far west; mica, not to be found in this region; galena, etc.

Copper was evidently a rare and highly valued article among them; its rarity seems to indicate that they at least did not work the copper mines of Lake Superior or anywhere, and were not much in communication with any people who did.

Small nuggets of drift copper are still occasionally found here; we have several in our museum, picked up in this vicinity; and a numerous people dwelling here for a long period would be likely to find the greater portion of all such specimens existing here, and if they did so, that would furnish a quite sufficient source of supply of material for all the copper relics yet discovered without the necessity of drawing upon the mines. That the mound-builders had no knowledge of the art of smelting is well shown by the following facts:

The numerous copper axes, awls, beads, etc., and the very rare silver ornaments are evidently of the pure native metal and hammered; none are found bearing the slightest indications of having been melted; no moulds or crucibles, or fragments of any, have ever been found, although they would be of the most imperishable character, more so even than the pottery, which is exceedingly common.

If cast in moulds, many would be made of identical size and form, whereas no duplicates are ever found.

If, as has been argued, though I believe on very insufficient grounds, the copper implements collected in Wisconsin exhibit indications of having been formed in moulds, it would have no bearing whatever upon the origin of those of Iowa, which are of very different type; those of the north being mostly of the more modern forms of spears and knives; and not unusually found in mounds, but scattered on the surface or in the shallow Indian graves.

The copper "axes," so called (and very inappropriately, too), in no instances show any indications of having been put to any use as tools, or even of having had handles attached. They were doubtless valued and kept as badges of rank or wealth, and held in high esteem.

Those people undoubtedly smoked tobacco, not, however, as a recreation or habitually for pleasure, but as a kind of ceremonial observance. The pipes are often very elaborately and beautifully carved out of a great variety of kinds of stone, generally of a rather soft character, and were apparently held in very high estimation, perhaps almost sacred. They are all in the Upper Mississippi Valley of the same general type, having the flat, curved base, which is perforated to serve as a stem and not at all adapted to retain in the mouth for smoking continuously; which fact, with the smallness of the bowl itself, would indicate that it was to be used by passing from one to another of the persons assembled.

They represent a great variety of animal forms, some difficult to determine, but among them are two well and distinctly representing the elephant, though differing somewhat from each other in form and position. These plainly and unmistakably show that the sculptors were acquainted with the elephants (the mammoth or mastodon), of which, though long extinct, numerous remains are found throughout this country.

Strangest of all, and most contrary to the opinion of archaeologists hitherto, it now appears that the mound-builders had a written language. Whence derived, or what its origin, is matter of the merest conjecture. What its affinities, or whether any connection with other written languages, ancient or modern, no one has yet determined.

The inscribed tablets in our museum, the only ones of much significance or importance perhaps, which have as yet been discovered in the mounds, have attracted much attention both in this country and in Europe, and by all eminent and well informed archaeologists are considered of the highest importance. They are certain to stimulate research, which will doubtless lead to further discoveries, until it may well be hoped that the key to the language may ultimately be discovered, and something of a history of this ancient people may be made out as written by themselves.

Whether the language was understood by all, or only by a more learned few, or whether these tablets were heirlooms and cherished relics, cannot now be scarcely even guessed.

A rather significant circumstance, perhaps, is the fact that in the same mound with the two tablets first found, were the bones of a young child, partially preserved by the

contact of a large number—about 300—copper beads, indicating it to be an important personage, and that persons of high rank were buried there.

Some doubts of course have been expressed regarding the genuineness of the tablets, though not to any great extent by competent and candid archaeologists, and we feel no uneasiness on that account.

The tablets have been sent to the Smithsonian Institution for examination, and were retained there and subjected to the most thorough scrutiny for two months, during which time the National Academy of Sciences held its meeting there, and the heliotype plates of them were obtained under the directions of Professor Baird himself. They were also exhibited throughout the sessions of the meeting of the American Association for the Advancement of Science at Boston last August.

Any author or other person who cared to inform himself of the facts, has and has always had ample opportunity to do so, and would at once see that the circumstances of the finding were such as utterly to preclude all possibility of fraud or imposition.

The evidence that they are coeval with the other relics, that is, that they were inhumed with them and before the mound was built, is ample and conclusive, and will be so considered by any unbiased mind.

No prehistoric relic ever found has better evidence to establish its genuineness than these, and not one suspicious circumstance in connection with them has been pointed out, nor can there be.

We shall confidently hope for and gladly welcome further discoveries by whomsoever made tending to throw more light upon this still obscure and intensely interesting problem of our earliest predecessors on this continent.

VALUABLE EGYPTIAN PAPYRI DISCOVERED.

BESIDES being memorable for the appearance of the comet, the year 1881 must ever hold a high place in the annals of Egyptological discovery. M. Maspero, the recently appointed director of the Boulak Museum, is at the present moment in Paris actively engaged in preparing for publication the texts of the Pyramids of the fifth and sixth dynasties, which were opened last spring at Sakkarah. The forthcoming number of his "Recueil" will contain the entire text of the Pyramid of King Ounas, the last king of the fifth dynasty.

But the saying that "it never rains but it pours" may be now fairly applied to archaeological discovery. Long before the *savants* have had time to peruse, ponder over, or profit by the wonders unearthed at Sakkarah, they are now suddenly overwhelmed with a fresh supply of material in the form of the largest papyri yet known, and by the apparition of the mummies, with all their mortuary appendages and inscriptions, of no less than thirty royal personages. This discovery which has just been made calls for special interest in England, for among the thirty royal mummies are to be found those of King Thothmes III. and of King Ramses II. It was the former who ordered the construction of the obelisk which now stands upon the Thames embankment, and it was the latter who, 270 years afterward, caused his own official titles and honors to be inscribed upon its faces beside those of Thothmes III.

These two monarchs now lie side by side in the Boulak Museum, and even the flowers and garlands which were placed in their coffins may to-day be seen encircling the masks which cover the faces of the deceased just as they were left by the mourners over 3,000 years ago.

Last June, Daoud Pasha, Governor of the Province of Kench, which includes the ancient Theban district, noticed that the Bedaween offered for sale an unusual quantity of antiquities at absurdly low prices. The Pasha soon discovered that the source of their hidden treasure was situated in a gorge of the mountain range which separates Deir-el-Bahari from the Bab-el-Mulouk. This gorge is situated about four miles from the Nile to the east of Thebes. Daoud Pasha at once telegraphed to the Khedive, who forthwith dispatched to the spot Herr Emil Brugsch a younger brother of Dr. Henry Brugsch Pasha, who, during M. Maspero's absence in Paris, is in charge of all archaeological excavations in Egypt.

Herr Brugsch discovered in the cliffs of the Libyan mountains, near the temple of Deir-el-Bahari, or the "Northern Convent," a pit about 35 feet deep, cut in the solid rock; a secret opening from this pit led to a gallery nearly 200 feet long, also hewn out of the solid rock. This gallery was filled with relics of the Theban dynasties. Every indication leads to the conviction that these sacred relics had been removed from their appropriate places in the various tombs and temples, and concealed in this subterranean gallery by the Egyptian priests to preserve them from being destroyed by some foreign invader. In all probability they were thus concealed at the time of the invasion of Egypt by Cambyses.

Herr Brugsch at once telegraphed for a steamer, which on Friday last safely deposited her precious cargo at the Boulak Museum. The full value of this discovery, of course, cannot as yet be determined. The papyri have not yet been unrolled, nor have the mummies been unwrapped. Conspicuous by its massive gold ornamentation, in which cartouches are set in precious stones, is the coffin containing the mummy of Maut Nedjem, a daughter of King Ramses II. Each of the mummies is accompanied by an alabaster canopic urn containing the heart and entrails of the deceased.

Four papyri were found in the gallery at Deir-el-Bahari, each in a perfect state of preservation. The largest of these papyri—that found in the coffin of Queen Ra-ma-ka—is most beautifully illustrated with colored illuminations. It is about 16 inches wide, and when unrolled will probably measure from 100 to 140 feet in length. The other papyri are somewhat narrower, but are more closely written upon. These papyri will probably prove to be the most valuable portion of the discovery, for in the present state of Egyptology a papyrus may be of more importance than an entire temple; and, as the late Mariette Pasha used to say: "It is certain that, if ever one of those discoveries that bring about a revolution in science should be made in Egyptology, the world will be indebted for it to a papyrus."

No less than 3,700 mortuary statues have been found which bear royal cartouches and inscriptions. Nearly 2,000 other objects have been discovered. One of the most remarkable relics is an enormous leather tent, which bears the cartouche of King Pinotem, of the 31st dynasty. This tent is in a truly wonderful state of preservation. The workmanship is beautiful. It is covered with hieroglyphs most carefully embroidered in red, green, and yellow leather. The colors are quite fresh and bright. In each of the corners is represented the royal vulture and stars.—*Cairo Letter to the London Times*.

¹ Kirby and Spence, loc. cit., ii., 469, quoted from Sturm's Deutschland's Fauna, i., 27.

² Kirby and Spence, loc. cit., ii., 519, quoted from Illiger's Mag., i., 48.

³ The number of facets or cornua vary from 50 (in the ant) to 3,650, the latter number being counted by Geoffroy in the eye of a butterfly.⁴ Packard, i., c., p. 25.

⁵ Packard, loc. cit., p. 26.

⁶ Wallace, Contributions, loc. cit., p. 302.

⁷ Wood, "Man and Beast," loc. cit., p. 23.

⁸ Wood, "Man and Beast," loc. cit., p. 49.

⁹ Descent of Man, 1st ed., i., p. 46.

¹⁰ Descent of Man, 1st ed., i., 45, 46.

¹¹ Wallace, Malay Archipelago, N. Y. ed., p. 52, 70.

¹² Travels in Equatorial Regions of South America, i., 240.

THE INTERNATIONAL MEDICAL AND SANITARY EXHIBITION, LONDON.

This interesting exhibition was organized by the Committee of the Parkes Museum of Hygiene, in connection with the International Congress of Medical Men, held in August last, in London. The collection included all the best known and novel sanitary and medical appliances, contributed by some four hundred and fifty firms, and embraced a very wide range. Thus, in one section we see surgical apparatus, and in another appliances for the drainage and ventilation of ordinary dwelling-houses; here we find models of ambulances for the battlefield, and there again a series of hospital beds from the various London hospitals, fitted with the most improved mechanical inventions for rendering the sufferer more comfortable in his hours of sickness.

It is this portion of the exhibition which has been chiefly chosen by our artist for illustration. Thus, in his two first sketches he depicts the method of treating croup and other throat complaints in St. Mary's and Guy's hospitals. A moist atmosphere being necessary, steam is supplied from a small boiler, and is kept around the patient by means of a small tent erected over him. In the third illustration, however, we are transported to the battlefield, and shown what can be improvised in an emergency. Thus, the wounded man's arm and leg, which are supposed to be injured, are kept in proper position by means of a Snider rifle and a couple of bayonets. In No. 4 we are taken back to civilized hospital life.

Good bathing is one of the essential requirements of a

TYPHUS FEVER IN NEW YORK.

At a recent meeting of the New York Academy of Medicine, Dr. E. G. Janeway read a paper on the above subject.

As a preliminary step, reference was made to mortality records, and a study of them showed that the existence of typhus in this city in previous years had been greater apparently than in reality. For example, many German physicians wrote upon the death certificate "typhus," without adding abdominalis or some other qualifying word, when death was really caused by typhoid fever. During the years 1878, '79, '80, returns of death from typhus fever had been made in only four cases for each of the first two, and three for the last year. There was, however, danger lest a false security be accepted because no known case of importation existed. Dr. Janeway then gave certain details of cases which had a bearing on the question of the

SPONTANEOUS ORIGIN

of the disease. A family of adults living in a tenement house of the ordinary type were attacked, and the history of the sickness, the character of the eruption, and the autopsy of the mother proved the disease to be typhus fever. Moreover, although he had cautioned the nurses and the attendants, one of the latter contracted the disease, but recovered. A number of the members of another family were sick, and close inquiry elicited the information that the father had had what was supposed to be pneumonia, but had relapsed. In both families the sick occupied inner bedrooms, and the windows were kept closed, through fear of taking cold. A

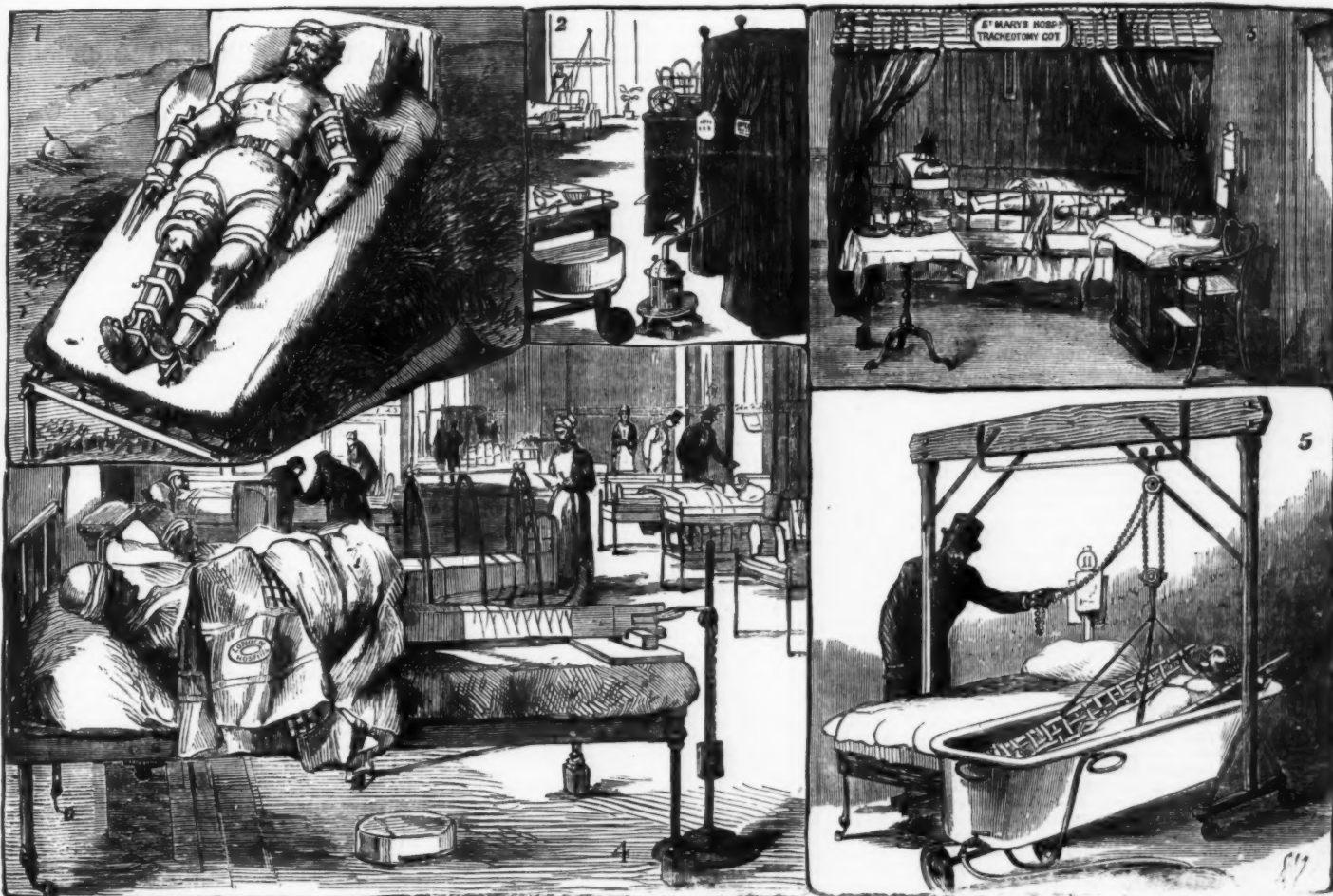
Two hundred and seventy-three cases had been admitted two hundred and thirty-five males and thirty-eight females. There were sixty-four deaths; fifty-five males and nine females. Under the age of fifteen there were 8 cases and no deaths; between fifteen and twenty, 17 cases and 3 deaths; twenty and twenty-five, 44 cases and 5 deaths; twenty-five and thirty, 48 cases and 6 deaths; thirty and thirty-five, 39 cases and 10 deaths; thirty-five and forty, 41 cases and 9 deaths; forty and forty-five, 28 cases and 10 deaths; forty-five and fifty, 15 cases and 5 deaths; fifty and fifty-five, 13 cases and 4 deaths; fifty-five and sixty, 7 cases and 5 deaths; sixty and sixty-five, 5 cases and 1 death; sixty-five and seventy, 6 cases and 3 deaths; seventy and seventy-five, 2 cases and 2 deaths; seventy-five and eighty, 1 case and 1 death. The cases from Hart's Island, all tramps, showed the greatest percentage of mortality; there were eleven cases and eight deaths.

The disease spread almost entirely by personal contact. There were certain cases which were variations from this general rule. Certain cases were then related which showed that some persons were much more susceptible to the poison than others.

No physician had contracted the disease. Of the orderlies and nurses, eight had contracted it.

The measures adopted to prevent the spread of the disease have been removal of the patients, thorough fumigation of the apartments and burning of the clothing, and subsequent regular inspection of the places from which the patients came.

Dr. Janeway then spoke of the desirability of legal authority to enforce internal quarantine. The treatment had con-



1. Extremity Dressing on the Battlefield. 2. Ward Tent and Apparatus for Steaming Throat and Bronchial Cases, Guy's Hospital. 3. Ditto, St. Mary's Hospital. 4. A Bad Accident Case; London Hospital. 5. Bath Lift; Middlesex Hospital.

NOTES AT THE INTERNATIONAL SANITARY AND MEDICAL EXHIBITION, LONDON.

hospital, and by an admirable mechanical arrangement in use at the Middlesex Hospital a patient, however helpless he may be, can be transferred from his bed and swung in a species of litter by a most ingenious crane contrivance into his bath with ease and comfort.

The unfortunate dummy in the last sketch, and who lies in a bed from the London Hospital, has apparently met with an accident which has caused him serious injuries. Above his head hangs a frame holding the papers which concern his case, headed by the name of the well-known surgeon, Mr. Jonathan Hutchinson. Over his knees is an iron erection, known as a cradle, to keep the bedclothes off his wounded limb, which is dressed in splints and bandages. The weight hung at the end of the bed is constantly extending his legs and assisting in his cure. His head also is bandaged and kept cool by a bag of ice. In such a condition he is most fortunate in having a bed in the London Hospital where he certainly receives the most skilled treatment for his injuries, as, through its situation at the manufacturing end of the metropolis, this institution receives as many accidents as any other three hospitals in London.

Hospital wards and surgical appliances apart, we should strongly recommend all householders to visit the Exhibition, as it contains an immense variety of ventilators, of slow-combustion grates, and of simple dwelling-house appliances, which, if adopted, would not only lead to improved health, but to a great economy of household expenditure. Among other contributions we may mention a model of Dr. Siemens' crematory furnace, and of a number of designs of the various systems of cremation, and a room lighted by Balmain's luminous paint.—London Graphic.

boy in a room above the second family was sick with what an old physician said was old-fashioned "ship fever." Beyond those places it was absolutely impossible to trace the origin of the disease.

In those cases there was a continuous fever, which had all the elements of typhus fever. It attacked adults, was contagious, was communicated to nurses, and at autopsy there was absence of lesions of the bowels.

Dr. Janeway gave an account of the existence of typhus fever in Philadelphia, during the last autumn and winter, and also in Camden, N. J., as proved by autopsies made by Dr. Tyson, and examinations made by Dr. Pepper, of Philadelphia.

Statistics concerning the existence of the disease in Dublin, Liverpool, and St. Petersburg were then read, showing that cases had been in those cities during the last autumn and winter—in the last named city, ten to thirty deaths occurred weekly, and in Dublin the number of deaths from typhus fever reached ten in some weeks.

Prior to the active outbreak in New York, the disease existed in more than one place in New York, but the outbreak might be said to have begun in the week ending March 19, 1881, in the Shiloh Shelter, and from that lodging-house thirty cases came. Of the first fifty-six cases probably many other physicians could give more or less complete histories of a large number of them.

The first autopsy was made March 19, 1881, on the body of a man who died March 17, 1881, in Bellevue Hospital. There was absence of the lesions belonging to typhoid fever and remittent fever, and the conditions described as present in typhus fever ordinarily existed.

sisted chiefly in administering milk and beef tea, and using Kibbie's cod or cold sponging, and giving the patients fresh air in tents.

He also spoke of the undesirability of cheap lodging houses, where the tendency was to take in as large a number as possible. A limit should be placed upon the number who were to occupy one room, and an ordinance had been passed by the Board of Health requiring three hundred cubic feet of air-space for each lodger. There should be a pavilion attached to each hospital, with separate rooms, where cases could be placed to await the development of the disease, or removal.

Dr. Janeway then referred to four cases of

DIPHTHERIA.

the histories of which were so peculiar that he wished to place them on record.

Last autumn he saw in consultation in Brooklyn, in a large, well ventilated house, open upon all sides, a child sick with diphtheria. The patient died on the following day. Shortly afterward another child sickened with the disease, and also died. Soon afterward the family went to Aiken, S. C., and there all the members took cold, but no diphtheria developed. From there they went to Pilatka, Fla., and shortly after their arrival a trunk was opened and a woolly rabbit taken out and given to the children to play with, and within three days another child sickened with diphtheria, and died at the end of a week. The remaining child was removed to Jacksonville and Sanford, where no diphtheria had existed, but at the end of five weeks this child was attacked with the disease, and died.

The President, in bringing the paper before the Academy for discussion, remarked that it was but just to say that one of the medical gentlemen constituting the Health Board had done his duty thoroughly with regard to typhus fever.

Dr. Austin Flint remarked that the facts set forth in Dr. Janeway's paper touched important etiological questions; and, first, whether typhus fever required always a specific cause—or, if you please, a germ—developed in the body of one affected with the disease, or whether its special cause was capable of being produced *de novo* by the occurrence of peculiar conditions at certain times and in certain places.

That was still an open question, and facts could be adduced which sustained an answer given in either the one or the other direction. Many years ago he met with an instance, and reported the same, in a part of the country where typhus fever had never been known to occur, and there were several cases.

Those cases developed in persons living in small rooms, without regard to cleanliness or ventilation, and were typhus fever, as proved by the eruption and autopsical examination; but it was impossible to trace the disease to importation; and yet, perhaps it was the more rational supposition that in some way the germ was received, than that the disease was developed *de novo*. Dr. Janeway has observed analogous instances. But assuming, for the sake of study, that the introduction of a germ was necessary, it had not yet been ascertained how long that germ might retain its vitality. Perhaps it might retain it for years, waiting for the combination of circumstances favoring and necessary to its development. How long could it remain latent and retain its vitality? was an important field for inquiry. Might it or might it not retain its vitality, like seeds which had for scores and hundreds of years remained inactive, and yet developed plants when exposed to the conditions necessary to growth?

Another important point related to exposure to the contagion. Evidently something more than mere exposure was required. There was a vast difference in the susceptibility of different persons to the contagion of typhus fever.

With regard to the prevention of the spread of the disease, Dr. Janeway had not presented evidence of the success obtained by the Board of Health in stamping it out; but doubtless that object would be accomplished ultimately. Isolation, cleanliness, disinfection, and ventilation were the powerful means by which this end was to be attained.

In conclusion, Dr. Flint said that he could not refrain from speaking of the noble work done, in years past, by the Health Board of the City of New York. Its labors against cholera, and more recently in stamping out small-pox by isolation, disinfection, and vaccination, were worthy of special and honorable mention.

Dr. Alfred L. Loomis remarked that he had been deeply interested in the history given so carefully by Dr. Janeway, for the reason that it brought to mind his own experience in connection with the outbreak of typhus fever, more severe than the present, which occurred in this city in 1862. At that time he had charge of the fever wards in Bellevue Hospital, and in a single day fourteen patients with typhus fever were brought in from various parts of the city, but the majority of them came from the region of Baxter street. A tour of inspection was immediately begun, and finally he traced the disease to the upper story of a tenement house in Mulberry street, in the most filthy portion of this city, where a little girl was sick, who sickened on board of a ship that had typhus fever on board, and came from Ireland.

He did not believe that it was necessary, in explanation of a severe outbreak of typhus fever, to trace it directly to importation at the time of the outbreak; but he was convinced, from the history of the disease, so far as the literature was concerned and so far as his own experience extended, that it was a disease which was indigenous to certain localities; that in certain localities it might always be found; and that, when it was developed in localities where it was not indigenous, it was the result of importation; and the same might be said of yellow fever. We did not expect that disease to appear in this city spontaneously, and yet it would spread rapidly here when atmospheric and other conditions were favorable for its spread and development, after it had once been introduced. It was quite probable that typhus fever entered New York oftener than was generally supposed; but it was necessary that certain conditions be present in order that the poison might become effective in reproducing the disease. He believed that the poison might remain dormant, perhaps for two or three years, and then under favorable conditions develop the disease.

The paper brought up three questions:
First.—Was typhus fever ever of spontaneous origin?
Second.—Was it ever transmitted from one person to another, except by direct contact?
Third.—What were the most certain means of arresting its development and spread?

From Dr. Janeway's history of the present outbreak and spread of the disease, it would seem that most of the cases were the result of direct personal contagion. In no instance has he been able to trace the disease to importation. Indeed, it would be impossible for any observer to trace all cases to their origin. For, as stated in the paper, a large percentage of those attacked by the disease were "tramps," and New York was well adapted to receive "tramps" from all parts of the country, and it was almost next to impossible to trace any disease appearing among them. The difficulties in deciding the question whether or not typhus fever was of spontaneous origin in a large city were almost insurmountable. The cases reported by Dr. Flint were perhaps the strongest on record; and yet, with only a few such cases, we were scarcely justified in regarding the disease as one of spontaneous origin.

With reference to conveying the disease by personal contact or clothing, the following were the facts concerning the outbreak in 1862. No employee in the hospital who was brought in contact with the clothing of fever patients contracted the disease. Every one whose duty it was to carry the fever patients from the reception room to the hospital took the fever. Every physician and nurse who had the care of typhus fever patients contracted the disease; those who were on the surgical side escaped. Every clergyman, with one exception, and he kept at a good distance, who came to administer to the patients in the fever ward, contracted the disease.

Those facts differed from those given by Dr. Janeway in connection with the present outbreak. There must have been a difference either in the intensity of the poison or in the exposure of the individuals. Besides, the less number of cases among the attendants upon the sick, both physicians and nurses, was doubtless due considerably to the fact that medical men know better now than formerly how to care

for themselves under such circumstances, with reference to ventilation, etc. No doubt that typhus fever poison might be conveyed by clothing, but, in order that it shall become sufficiently intense to develop the disease, there must be personal contagion or exposure.

Dr. Loomis believed that it was not so much idiosyncrasy that exempted certain persons—except the occasional persons who were apparently exempt from infectious diseases of all kinds—from typhus fever, as it was feebleness of the exposure to which they were subjected. In other words, it was the intensity of the exposure rather than individual idiosyncrasy that regulated the contracting of the disease.

With reference to preventing the spread of typhus fever, he thought that we did not yet know of anything which equaled fresh air in neutralizing the influence of the poison. Its spread could not be prevented by disinfection while persons sick with the disease remained in the building. Thorough quarantine was necessary, not only of the sick, but of the well, until it was determined whether or not those who had been exposed were to have the fever. To remove the danger from rooms they must be not only disinfected, but exposed fully to the continued influence of fresh air.

Another interesting fact in Dr. Janeway's statistics was the greater rate of mortality among those who had passed the middle period of life.

THE HUDSON'S BAY EXPLORATION.

THE Geological Survey of Canada has devoted the past five years to the exploration of Hudson's Bay and the streams which flow into it. The results of the work are summed up as below by the Assistant Director of the Survey, Prof. Bell:

The extreme length of Hudson's Bay, including James' Bay and some of its northern arms, is about 1,200 miles; its width 600 miles, and its area about 500,000 square miles. The prevalent idea that it is situated in the Arctic regions is sufficiently extraordinary, seeing that its southern end is south of London, England, and, notwithstanding its great length, its northern part is still to the south of the beginning of the Arctic region. Many rivers are laid down on the map as entering Hudson's Bay, most of which are at present almost unknown. Beginning at the south is the Moose River, a large, short branch formed by the junction near the sea of the Missinabi, Ozottika, Mattagami, and Abitibi. To the east are the Hannah Bay River, the Noddawai and Rupert's River; higher up on the same side are the Eastmain River, the Kisi-Sipi or Big River, Seal, Great Whale, Little Whale, several rivers flowing into Richmond Gulf, the Nastapoka, and the Langlands River, and numerous small streams further north. On the west side of the bay, northward from Moose Factory, are the Albany, Attawapiskat, Equan, Trout, Wenish, Severn, Hayes, Nelson, Churchill, North and Seal Rivers, besides many more beyond of which scarcely anything is known. The largest of all the rivers is the Nelson, which is one of the great rivers of the world; its waters are muddy with the fine clay matter brought from the Rocky Mountains by way of the Saskatchewan, and that brought from the United States by the Red River of the North. The Churchill is a fine stream, and comes next in order, having bright and clear water. The Kisi-Sipi or Big River is probably the third in size. The Albany, Moose, Eastmain, and Rupert's Rivers come next in order.

Unfortunately, most of these rivers are not navigable, except for small craft, to any great distance from the sea. The Albany is the best in this respect, as it might probably be ascended by powerful steamers as far as Merlin's Falls, a distance of about 250 miles. Rapids or falls occur on all the rivers on the east side of the bay at short distances from their mouths.

Several of the principal rivers have been surveyed by Dr. Bell, and will shortly be represented on the maps. Among them are the Moose and all three of its great branches, a portion of the Albany and some of its branches, Hayes River and its tributaries, the Nelson, the Great Churchill, and the Little Churchill (a branch more than one hundred miles long). This work of surveying and exploring the rivers of Hudson's Bay has also since been continued by others.

All around the head of James' Bay the country is low, and the water shallow and generally in a turbid condition from the constant ebb and flow of the tide over mud flats. Owing, however, to the great body of water discharged by the rivers, the water in the bay is only brackish, and is, indeed, quite fresh for miles off the mouths of large rivers. On the east side of the bay the coast line is tolerably straight as far as Cape Jones. The land is rather low and slightly undulating, well wooded, with some of the spruce timber of fair size. A strip of land several miles in width along a part of this coast appears suitable for agricultural purposes. In approaching Cape Jones the large trees begin to retire from the coast, and the woods are interspersed with park-like openings. The coast is fringed with a labyrinth of low islands, outside of which are numerous reefs. At Cape Jones, Hudson's Bay proper is opened, and here a great change occurs, the water becoming quite clear. The shore now begins to be higher and bolder, and this character increases to the north, the hills near the coast rising first to a few hundred feet and then to one thousand and even two thousand feet above the sea level. Instead of the gently undulating outline which has hitherto prevailed they become rugged and precipitous. The islands are now bold, and lie in regular succession, varying in size from mere rocks to thirty miles in length, and mostly with a crescent-shaped outline, the convex side being next to the shore. This side generally presents a cliff of greater or less height, while the top of the island slopes down to the west, dipping at a gentle angle under the sea. Dr. Bell afterward described the peculiarities of the islands and sounds met with after rounding Cape Jones, and particularly a remarkable sheet of water named Richmond Gulf, which is connected with Hudson's Bay by a very narrow inlet about a mile long. At this distance north the country of the Esquimaux is reached, and Dr. Bell says they are very different people from the Indians, being industrious, outspoken, and even demonstrative; they are also very friendly and generous to a fault.

The climate of Hudson's Bay is found to be pleasant in summer, and while this region does not enjoy any of the good effects of the Gulf Stream it is also far enough removed from the Arctic current of the Atlantic to escape the bad influence which it exerts over the eastern coasts of the Dominion. Dr. Bell gives a curious explanation of the cause of the favorable summer weather of the Canadian northwest Territories, owing to which there can scarcely be said to be a northern limit to the wheat-growing region in this direction, but rather an eastern limit. The finest soil in the world is to be found in the Red River and Saskatchewan regions, which drain into Hudson's Bay, and

even in the more immediate basin of the bay there is much good land. The greatest extent of available land is that joining the valley, or rather basin, of the Moose River and its wide-spreading branches. A very wide, level branch extends inland from the western shores of the Hudson's Bay, including James' Bay, a large proportion of which may some day be found suitable for stock-raising or some other useful purpose. But little is yet known of the capabilities of this region.

In the southern part of the basin of the Moose River a large proportion of the useful timber trees of Canada, including the red and white pine, is to be found; but to the north of this region, on both sides of the bay, the number of the species gradually diminishes, and at last trees of every kind disappear, only shrubs being met with near the coast. Spruce is the last to vanish, continuing to be of good size as far north as Ports George and Churchill, on the east and west coast respectively. Tamarac grows nearly as far north, but the northern limit of the Banhipan pine scarcely touches the south end of James' Bay, though it extends much higher to the northwest. Balsam is found somewhat further north, but white cedar is seldom met with. Of deciduous trees and bushes, willows are found farthest north, some of the varieties extending higher up the bay than any point reached by Dr. Bell. Next to these the balsam, poplar, and aspen are the most northern, and the white or canoe birch extends nearly as far.

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